ENGINEERING NEWS

ON Monday last, March 12, New York and its vicinity, as well as the whole Atlantic coast north of Washington, experienced the most severe snow storm known for many years, and an entirely unprecedented one as respects the violence of the wind, and the date at which it occurred. The details of the resulting inconvenience and loss will be too well remembered to need recalling, and no one whatever seems to have recalled since the storm that the prediction of the Signal Service, published on the morning after the storm which began at midnight was "In and near the city to-day there will probably be clearing colder weather, preceded by light snow." Three hours before this was put in type it was snowing furiously and blowing a gale, making the failure of the Signal Service predictions one of the most complete, and, so far as yet appears, inexcusable in its history, for the storm was almost a continual one, and of unusual duration as well.

AN interesting problem for the street authorities is how to clear the streets for traffic and to dispose of the snow before a thaw shall melt it and cause perhaps still more serious injury to property. It is to be feared this problem will be very poorly solved. On the Brooklyn Bridge the carrying pulleys of the cable line were blocked with snow, and on the approaches the tracks were packed with snow up to the rails. For two days and a half, trains of three cars were run by locomotives, the rear engine stopping at the summit of the grade and running back to take its place at the head of the next train On Tuesday an ice jam formed across the East river and for an hour or so people walked across. On the railroads an unprecedentedly great number of trains were snowed in between stations, traffic was at a standstill, and mails were undelivered for three days. One calamity which we greatly feared was escaped however. ENGINEERING NEWS has been able to appear promptly on time, although it looked at first very doubtful, our printing office having been almost deserted for two days, which is a large fraction of six.

TELEGRAPHIC communication has been almost completely suspended throughout the entire area of the storm, forcibly suggesting, we hope, that there should be at least a few main circuits connecting our leading cities buried underground, as is so commonly and extensively done in Europe. It is preposterous, for instance, that in telegraphic communication, a string of cities like Boston, Worcester, Springfield, Hartford, New Haven, New York, Newark, Trenton, Philadelphia, Wilmington, Baltimore and Washington should not be placed beyond the danger of such frequent and easy interruption. If to this were added another circuit through Albany, Rochester, Buffalo, Cleveland. Toledo, Detroit, Chicago, St. Louis, Louisville, Cincinnati, Pittsburg, Harrisburg and Philadelphia, great public annoyance and private loss would be saved at very moderate expense. Were the telegraph system in the hands of the Government, this would quite certainly be demanded and done, but we presume it is too much to hope of the Western Union.

THE most serious railroad accident of the week was a derailment on the New York, Lake Erie & Western Railroad at Scio, N. Y., on March 11. The engine, tender and two sleeping cars left the track; the second sleeper slewed round and was crushed against the brickwork of a tank; the forward car was dragged some distance. One person was killed and 13 injured. The accident was due to the storm and was only one of dozens of others, two of the most important of which were on the New York Central and the Third Avenue Elevated.

THE following bridge accidents are reported: On March 5, the Pee Dee river bridge, near Florence, S. C., on the Wilmington, Columbia & Augusta Railroad, was destroyed by fire. — On March 13, a trestle on the Canadian Pacific Railway, at North Bay, Manitoba, was reported to have given way, throwing a passenger train into the rocky chasm.

MUCH damage has been done recently in Mexico by the inroads of the Rio Grande river. The Mexican authorities at Paso del Norte are trying to protect the banks by mattress and rip-rap work, and similar works are projected on the American side. —An embankment near Bonham, Tex., on the Texas & Pacific Railway, was washed out March 4. Trains were flagged and no accidents occurred.

A good deal of work is now being done on the Denver & Rio Grande in reducing curvature and grades on the operated line. The purpose is to reduce the maximum curvature to 12°, and the maximum grades to 1.25 per cent. against east-bound freight, with the same maximum against west-bound except a small distance near Leadville where it will be about 2.00 per cent. This will require a tunnel at Tennessee Pass, west of Leadville, and some change of line near Red Cliff, and a general realignment from Leadville to Canon City. There are four locating parties now out. At one point 44° of curvature was taken out without greatly increasing work over what has been rendered necessary in raising grade above high water mark, now made necessary since the Colorado Midland built on the opposite side of the Arkansas.

THE Ontario & Western R. R. has begun the work of tunneling the divide between the waters of the Delaware and Susquehanna rivers, near Franklin station, the object being to do away with the zigzag, or series of reverse curves, now required for overcoming the heavy grades of the eastern slope of the mountain. The plans and specifications of the work, which were prepared some two years ago, contemplate a tunnel about 1,500 ft. in length, exclusive of the open approaches, and with a depth below the summit of the divide of about 150 ft. By means of the tunnel the maximum grade in crossing the mountain will be reduced from 104 to 75 ft., the distance between Walton and Sidney will be shortened about two miles, and passenger train time lessened about 15 minutes. The cost of the tunnel is estimated at about $500,000.

THE application of the New York & Long Island Railroad Co. for leave to construct a system of subterranean rapid transit lines at an average depth of 60 ft. below New York City and beneath the East river is still awaiting the action of the New York Board of Aldermen. Some rumors have been in circulation that several of the City fathers have made a little "combine" and agreed to hang up this company's application in the hope that some financial expressions of good will may be forthcoming, and it is even stated that a committee waited upon the officers of the company, and by various hints intimated that several members of the board would have to be "seen" before favorable action could be taken.

True or untrue, such things have been, and they constitute a greater barrier to enterprise and public improvements than any other difficulty with which officers of corporations have to cope. It is small comfort to reflect that we are not especially worse than our neighbors, and that State and municipal affairs are everywhere largely controlled by an element more or less hungry for "boodle."

FOR nearly three days of this week no communication of any sort was to be had with Boston; and for all New Yorkers knew, the Athens of America had met a similar fate to the ancient city of Pompeii. On Wednesday the first news arrived in the shape of a dispatch which had travelled from Boston to Rockport, Me., over the only telegraph line out of Boston which was in working order, thence to Newfoundland, and thence *via* the Atlantic cables to London and back to New York.

THE agitation for the removal of the Minneapolis grade crossings still continues. The improvement is opposed by the Minneapolis & St. Louis, and the company should not be too severely blamed for this as it is not in a financial condition to float the bonds necessary to raise the money for the work. A resolution was introduced into the Minneapolis Board of Trade, however, calling on all citizens to cease patronizing the company until it yielded. Such an attempt to make use of the boycott on the part of so wealthy and cultured a city as Minneapolis ought to be and probably will be defeated. The removal of grade crossings is a humane and commendable work, but it seems just that the city which reaps so large a share of the benefit and is abundantly able to pay for it should share in the expense instead of shifting the whole burden upon a railway corporation which has done a great deal in building up the city and whose prosperity and profits have been very small.

DURING the present year the Lake Shore & Michigan Southern Railway will begin the regular use of 48 in. angle-bars resting on three ties. It has been experimenting with these joints since the fall of 1884, and its present action is equivalent to an expression of satisfaction with the result. This is the longest rail-joint in the world, we believe. The West Shore joint, the first of the type, is only 36 ins. long and weighs 45 lbs. per pair, the Michigan Central joint is 44 ins. long and weighs 60 lbs. per pair, exclusive of bolts. The Chicago & Alton uses a 36 in. splice.

THE Clark St. viaduct, in Chicago, is reported to be in a rickety condition. The Superintendent of Bridges and Viaducts for the Northwestern R. R. Co. reports that he has found a hundred or more bolts and rivet-heads which have fallen from this structure, and that the decay is such that while the viaduct is not in a positively dangerous condition, it needs immediate attention.

THE Niagara Wood Paper Co., at Niagara Falls have now for 2 years been successfully employing a system of power whereby they utilize the water power twice over. The pulp mill is run by a turbine located 50 ft. below the top of the bank; but instead of letting the water run to waste after it has passed the wheel, it is diverted into another shaft and runs another turbine, 50 ft. below the first, which operates the paper mill. The gain to the company by this arrangement is about $30,000 per annum. There is a scheme now afloat to utilize this overflow from other mills as a source of power, and the claim is made that 5,000 extra horse-power can be so obtained.

AS every one knows, American practice in machine design dispenses with the use of gear wheels wherever practicable and transmits motion by belts and pulleys. English practice, however, still clings tenaciously to gearing and has made it do work which would be generally considered impossible on this side. London *Engineering* mentions a pair of double helical gear wheels in the wire works of R. Johnson & Nephew, of Manchester, which are 12 ins. wide on the face by 6 ft. 3 in. diameter and have been running for over a year at 220 revolutions per minute, or a speed at the pitch line of 4,319 ft. per minute. The wheels are said to run with scarcely any noise.

IN the United Kingdom the total amount of new railroad lines opened during 1887 was 191 miles, of which all but 27 miles were built by 18 existing companies. The exception was the West Clare Limited Ry., a light railway in Ireland, 27 miles long. The total number of new lines (built by the 19 companies) was 27, most of them being little extensions; the greatest length of any one line was 35¾ miles, and the shortest was ¾ mile. The system having the greatest mileage is the Great Western Ry., with 2,455 miles, the receipts for 1887 were $19,961,700; the London & North Western Ry., with 1,338 miles (the next longest system), had receipts amounting to $25,694,250.

THE Chicago, Burlington & Quincy earnings for January showed a decrease of $500,000. Earnings for the first week of March show a gain of $89,000 for the Canadian Pacific and a gain of $31,450 for the Mexican Central.

AGITATION of the grade crossing question in Pittsburg continues active. The Chamber of Commerce recently appointed a Committee in coöperation with the Engineers' Society of Western Pennsylvania, and this committee has made a report urgently recommending action, and stating that the railways appear to be ready and willing to take action, especially the Pennsylvania.

Report of the Board of Experts on Plans for Enlarging the Capacity of the Brooklyn Bridge.

The subjoined report was made public on Wednesday last, giving the conclusions of the Board of Experts as to what should, and what should not be done for enlarging the capacity of the Brooklyn Bridge. It will be seen that it corresponds exactly in both these respects with the substance of the views expressed by us in ENGINEERING NEWS of June 4 and 11, 1887, covering also a good deal more ground in regard to matters which were not then open for discussion. The course of events in this matter, which has extended over so long a period that our readers may have forgotten it, has been as follows:

On May 18, 1887, a report was submitted to the Board of Trustees embodying a proposed complete change in the present system of operating the cable cars, which had even then become notoriously inadequate to the requirements, and is still more so now. This plan proposed a change to what has since become known as the "head-house" or reciprocating system. It was received with favor by the Trustees, and after a brief discussion of 40 minutes it was resolved that the "new work and alteration contemplated in the report on terminal facilities just received be referred" to the terminal committee "with power to immediately proceed with the execution of the same." At the same session, Mr. C. E. EMERY, the author of the plan, was appointed Consulting Engineer. The public feeling was so strong that something better should be done, and done at once, or the technical knowledge of the daily press was so small, or both, that this action was hailed with unanimous and emphatic approval by the entire press of New York and Brooklyn.

On June 4 following we published an extended criticism of this plan, stating that it was "open to so many and such serious objections that we cannot but wonder that the trustees should have acted with such unusual, not to say improper haste," and specifying the objections to be that "it involves elements of danger which should in no case be tolerated, while other possibilities remain, even if the increase of capacity were as great as supposed," and that "it does not reach or approach the ultimate capacity which is attainable in other ways at less cost." In the same issue we stated that the "continuous circulation plan" over an endless track "strikes us as the only one worthy of serious consideration. Its advantages over any other possible system are many; the apparent difficulties and objections largely imaginary. It offers a vastly greater ultimate capacity than any other. But beyond these brief statements we must postpone all attempts to discuss the plan until a following issue."

In our following issue, June 18, we completed our disscussion of the head-house plan. Both of these articles were republished in full or in abstract by all the New York and Brooklyn dailies, and caused an immediate change in the attitude of the public and of the Trustees. Authority to immediately proceed with the execution of the plans was with drawn, and the ultimate result was the organization of the Board of Experts some six months later (Nov. 13) whose final report appears below. For reasons more fully explained in that same issue, which it seems unnecessary to recall in detail now, we reconsidered our purpose to outline the "circulating plan" for which we expressed a preference, and a description of it is now made public for the first time. To the best of our information and belief, no suggestion that a circulating or endless loop track in any form would be a desirable method of operating the bridge had ever before been made, but among the 16 rejected plans below referred to there were 6 or 8 of that type, all of them prepared and submitted after the publication of our original article, and all of them belonging to the distinctive type which the experts designate as "loop," as distinguished from the "circulating." The two types agree in this, that they use an endless track, around which trains circulate, which was the only feature distinctly suggested in our original article, but all the "loop" plans have these radical differences from the recommended plan:

1. The terminal loop is not symmetrical relatively to the axis of the bridge, nor enclosed under one roof, but turns out through the blocks and streets on one side only of the bridge axis, the station platforms being on the straight line only, beyond the curve.

2. The trains are short, 3 to 6 cars, and run very close together (10 to 50 seconds in the clear) on gauntleted tracks, splitting at the stations to go to duplicate landing platforms.

3. No arrangements are made for getting the crowd into and out of the cars and stations in a better or materially different way from that now in use, or for utilizing any part of the curved track for landing platforms.

With these brief explanations we leave the reports to speak for themselves.

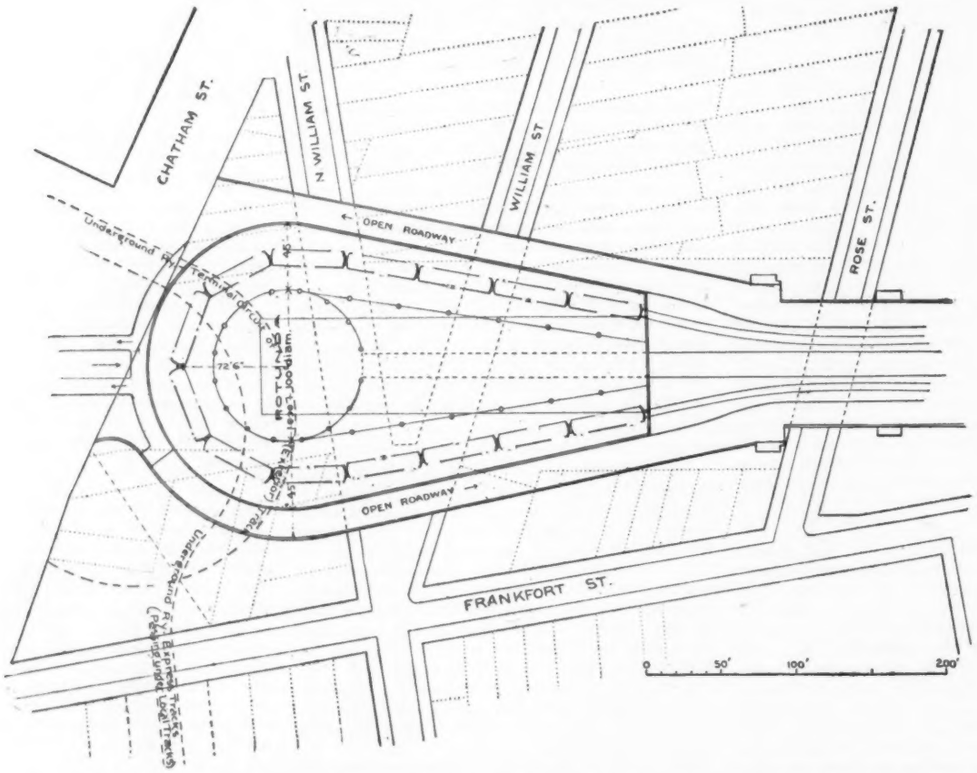


Fig. 1.—Sketch showing approximately the Arrangements of the Smaller New York Terminal of the Brooklyn Bridge.
(viz: 14-car Trains, 72½-ft. Terminal Radius, 100-ft. Rotunda.)
As originally proposed by A. M. WELLINGTON, M. Am. Soc. C. E.

[This station extends no further east than the east line of the present station building, the outlines of which are shown in the cut. It admits of arrangements within to afford all the traffic facilities (1 to 6) listed thereon beside the plan of the larger station, but there is not sufficient space within the building to properly provide for such a crowd of passengers as may be expected in the near future, although ample for the requirements of the next few years. The lots not already belonging to the bridge are shown by dotted lines on both Fig. 1 and Fig. 2.]

REPORT OF THE BOARD OF EXPERTS.

NEW YORK, Feb. 23, 1888.

TO JAMES HOWELL, Esq., *Prest.*, CHAS. MACDONALD, Esq., and THOS. C. CLARKE, Esq. — Committee on Terminal Facilities of the Trustees of the New York and Brooklyn Bridge.

GENTLEMEN:

The undersigned acting under your appointment as a Board of Experts, dated Nov. 10, 1887, to give an "opinion as to the best method of increasing the number and size of trains upon the Bridge, by such changes in the New York terminus as will allow of the same," respectfully submit the following

REPORT.

The Board convened on Nov. 12, for organization and general preliminary conference with yourselves and your Chief Engineer and Superintendent, for the purpose of ascertaining the scope of the whole problem you desired us to investigate and report upon.

At this meeting it was arranged that regular meetings of our Board should be held every Saturday afternoon, for the purpose of considering the plans and hearing statements made in regard to

them, by persons wishing to submit their views to us. In the intervening time between these regular meetings, considerable time has been devoted to the study of the plans presented to us, and to investigations in detail of the many phases of what has proved to be a very complicated problem.

In pursuance of this course, we have studied the plans with their accompanying written explanations, and heard full statements relative thereto offered by:

1st. MR. CHAS. E. EMERY, Civil Engineer.
2d. Mr. A. M. WELLINGTON, Civil Engineer.
3d. Messrs. WM. H. H. SISUM & ROBT. AVERY.
4th. Mr. C. C. MARTIN, your Chief Eng. & Supt.
5th. Mr. G. LEVERICH, Civil Engineer.

amounting in all to seventeen distinct plans, or modifications of plans, each of which has been severally taken under advisement, and all of which, we find, can be classified under one of the following general systems of operation:

I. The present system, which for brevity we call *The "Tail Switching" System.*

II. *The "Head House" System.*

III. *The "Loop" System.*

IV. *The "Circulating" System.*

Numerous other plans, and possible variations or combinations of suggested plans, occurring to us during the course of our investigations, have also been carefully studied.

As a necessary preliminary to a thorough understanding of the adaptability of any of these several systems to the requirements of the cable railway traffic of your Bridge, we were at the outset impressed with the paramount necessity of thoroughly analyzing and fixing the conditions of the traffic itself, pursuant to arriving, if possible, at a reasonable forecast of what volume should be provided for now, and in the near, as well as the distant, future.

To this end we have obtained from your superintendent, full and detailed statistics of what this traffic has been from its commencement, down to the close of the year 1887. Collateral to this, and as giving valuable information as to the general trend of traffic on analagous lines of public diurnal transportation, we have studied the statistics of the New York elevated railroads, New York horse car lines, Brooklyn ferry-boats, etc., etc., all of which shed valuable light upon the subject of the probable ratio of yearly increase; and incidental thereto have given careful consideration to a most interesting map, with its accompanying statistics, prepared and submitted by Mr. A. M. WELLINGTON, C. E., [the map given in this issue] showing the comparative residential areas in the cities of New York and Brooklyn, within equal distances of the City Hall, New York, which seems to afford very convincing reasons for the belief that the daily morning and evening traffic between the two cities may reasonably be expected to increase rapidly in the very near future, to an extent equal to the entire ultimate capacity of the Bridge

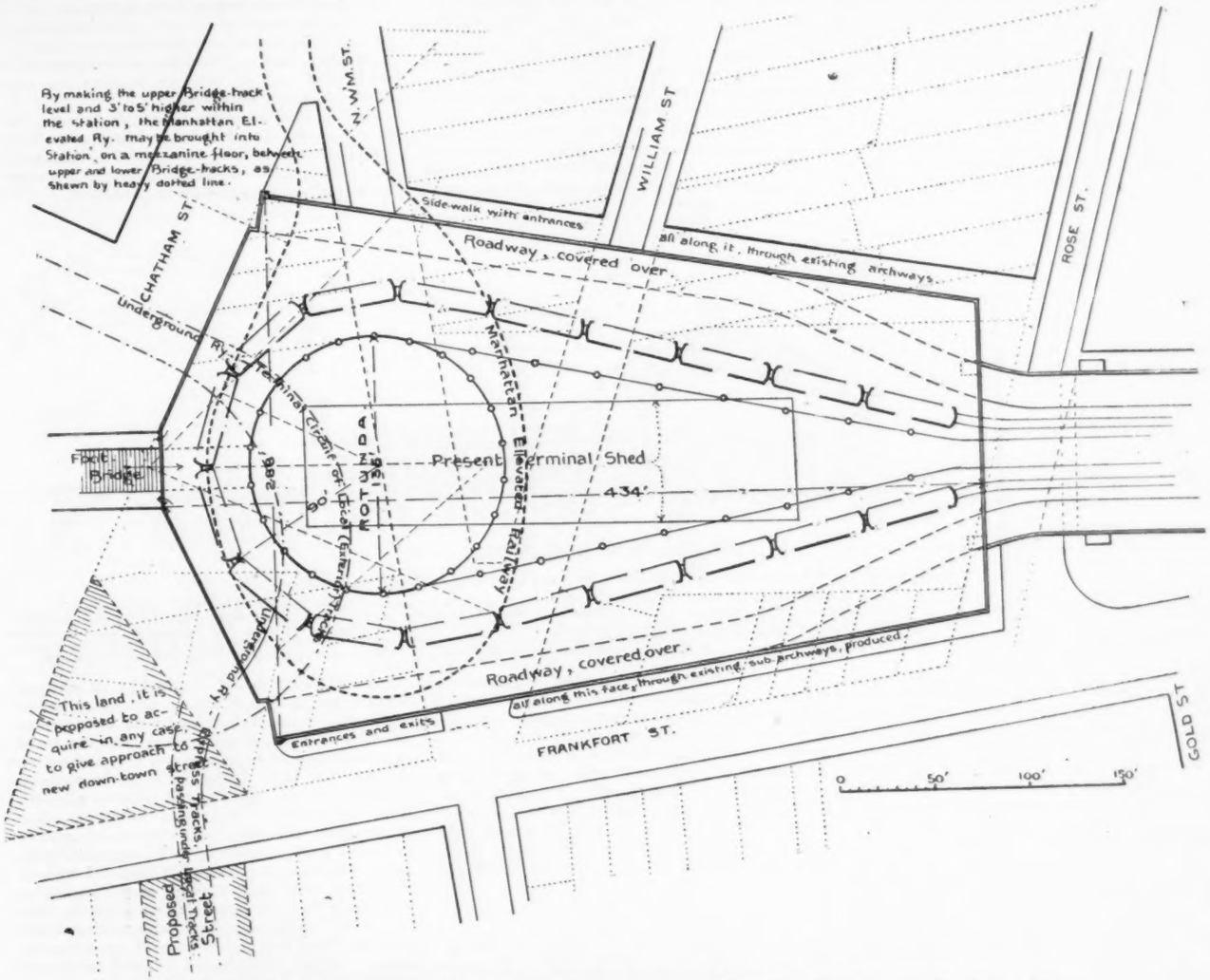

By making the upper Bridge-track level and 3' to 5' higher within the station, the Manhattan El. evaluted Ry. may be brought into Station on a mezzanine floor, between upper and lower Bridge-tracks, as shewn by heavy dotted line.
CHATHAM ST
WM ST.
WILLIAM ST
ROSE ST.
Side-walk with entrances
Roadway, covered over
all along it, through existing archways.
Underground Ry.
Terminal Circuit for Local Trains
ROTUNDA 135'
Manhattan Elevated Railway
Present Terminal Shed
434'
Foot Bridge
285'
Roadway, covered over.
all along this face, through existing sub archways, produced.
This land, it is proposed to acquire in any case to give approach to new down-town street
Entrances and exits
FRANKFORT ST.
GOLD ST
0 50' 100' 150'
Express Tracks
Passing under Local Tracks
Proposed Street

Fig. 2.—Sketch showing approximately the Preferable Arrangements of New York Terminal of the Brooklyn Bridge.
(viz: 18-car Maximum Train, 90-ft. Terminal Radius, 135-ft. Rotunda)
As proposed by A. M. WELLINGTON, M. Am. Soc. C. E.

This Station includes provisions for the following Rapid Transit facilities in successive floors from the Underground Station up; viz:

(1.) *An underground station for an up-town 4-track road (entered on a level from William St.).*

(2.) *New York and Brooklyn horse-car terminal on same grade and level as existing bridge roadways.*

(3.) *Terminal for 18-car trains over present cable tracks for local bridge service on a floor parallel (approximately) with the roadways and about 10 ft. above them, except for the Rotunda, which is level.*

(4.) *The Manhattan Railway on a level mezzanine floor at about the same level as the* FURTHER END *of the lower cable track.*

(5.) *A level track for the Brooklyn Elevated R. R. cars and possibly,—*

(6.) *An upper story of the same, in case it should be found feasible and expedient to provide for an upper track over the bridge roadways as well over the present cable tracks. The upper floor would then be about 52 ft. above Chatham St. sidewalk.*

CAPACITY.

	Cars per Train.	Trains per Hour.	Cars per Hour.	Seated Passengers (56 per car) per Hour.
Present local bridge service	18	26	468	26,208
Brooklyn Elevated { one floor..	16	26	416	23,296
R. R. direct service { second " ..	16	26	416	23,296
Total from Brooklyn, 3 floors. —			1,300	72,800
With 100 passengers per car, as now, this becomes, per hour				130,000
Against a present maximum capacity per hour of.....				12,000
The present traffic over the bridge being at the yearly rate of.....				30,000,000
This corresponds to an ultimate yearly capacity of about.....				355,000,000
The present traffic from up-town New York to the down-town business section being at the rate (including horse-cars) of nearly				200,000,000

In addition to the above, there will be nearly as large a traffic movement to and from the trains of the New York elevated and underground lines, which must be provided for within the station.

[By dispensing with end platforms, as proposed, 56 instead of 42 passengers per car can be seated, with the same floor area.]

railway, provided the proper facilities for handling it with due safety and convenience are provided.

Statistics furnished by your Chief Engineer and Superintendent show that the total number of passengers carried by the Bridge railway in 1886 was 24,478,324, and in 1887, it was 28,238,549, showing an increase of 3,760,225, or 15.36 per cent.

The averages resulting from actual count taken on seventeen days, in different months, of several different years, show that eighty-two per cent. of the traffic per day of twenty-four hours is carried in the day twelve hours between seven o'clock A. M., and seven o'clock P. M.; and also that the average maximum number carried in a single hour is fifteen per cent. of the number carried in a day twelve hours, being the hour between seven o'clock and eight o'clock A.M, carried from Brooklyn to New York.

From these data the following table of traffic for the next 10 years is estimated, on the assumption that the ratio of yearly increase will continue at 15 per cent. until 1892, and after that at the rate of 10 per cent. The probabilities, however, are strong that, should increased facilities be provided for comfortably and conveniently receiving, handling, moving and discharging the traffic, it will exceed this ratio of increase for a few years, up to a limit, however, which cannot be now determined, owing to lack of data on which to predicate it. But it is safe to assume that, for some years in the future, this traffic will increase approximately in proportion to the increased facilities provided for its accommodation. We therefore consider the figures given in this table as the minimum of expectancy, and we are of the opinion that, should the facilities hereinafter suggested and recommended be provided, it is quite probable that the maximum shown in it may be attained in less than the 10 years allowed for it.

ESTIMATED FUTURE TRAFFIC, NEW YORK AND BROOKLYN BRIDGE.

Year	Annual Total.	24-ho'r daily average.	12-hour average, 7 A. M. to 7 P. M., 82%.	1-hour average, 7 to 8 A.M. Br'k'yn to New York, 15%.	No of Cars seating 42 persons required for the 1-hour aver.
1888	32,474,330	88,980	72,960	10,944	261
1889	37,345,480	102,320	83,900	12,585	300
1890	42,947,300	117,660	96,480	14,472	345
1891	49,389,400	135,310	110,950	16,642	396
1892	56,797,810	155,610	127,600	19,140	456
1893	61,477,590	171,170	140,360	21,054	501
1894	68,725,350	188,280	154,390	23,158	551
1895	75,597,880	207,120	169,840	25,476	606
1896	83,157,670	227,830	186,820	28,023	667
1897	91,473,440	250,610	205,500	30,325	734

Present capacity, three-car trains, 1½ min. headway. 120
" " four-car " " " 160

Having arrived at this conclusion, it seemed clear that our efforts must necessarily be directed to the determination of the plan which will best provide terminal facilities, and a system of operating trains, in number and length, commensurate with the maximum capacity of the Br'dge railway when operated upon a system affording the closest approximation to absolute safety that sound judgment in practical operation will admit of; and in this connection, we beg leave to draw your attention to an aspect of the case which has not apparently thus far received the attention it deserves, and to respectfully suggest that the management of this great Bridge should assume the initiative in a manifestly much needed reform in our system of street car traffic generally. Yours being the only line of public travel, the management of which is wholly in the control of public authority, an example to others set by you, adding so materially to the comfort and safety of the travelling public, could not fail to secure its highest commendation; we refer to a reform in the existing barbarous custom of allowing standing passengers to crowd the cars to more than double their seating capacity, sometimes carrying over 100 in a car seating but 40. It is not a question for the standing passenger to decide, whether he prefers to stand rather than wait for the next train. Undoubtedly he has the right to determine for himself the value of a minute and a half or two minutes of his time, but he has not the right to enjoy this privilege at the expense of serious encroachment upon the rights of the passengers who have preceded him and found seats, nor to compel them to accept his views of comfort or necessity as a standard of theirs. In cars crowded to this extent, it is the seated passenger that not infrequently becomes the greatest sufferer, being often rendered incapable of moving, in any direction, under which circumstances the slightest panic or apprehension of danger becomes at once seriously magnified, subjecting the weak, timid and helpless to a degree of nervous suffering certainly not in accord with modern civilization, nor with a just regard to the rights and privileges of others. To remedy this, and give every passenger a seat, would, by 1897, with the assumed minimum of traffic, require the ability to circulate over six times as many cars in a single hour as is done on the present system of three-car trains, 40 trains per hour, and over four and one-half times as many as will be moved under the four-car train system soon to be inaugurated.

In selecting such a plan and system and in recommending it for your adoption, we do so with a grave sense of the responsibility resting upon us, to recommend nothing of a doubtful or experimental nature, or that is not based upon the results of experience deduced from the best and safest principles of modern railroad practice. In considering this phase of the subject, we desire to state that we are deeply sensible of the good judgment expressed in the injunction laid upon us by the following words in your letter appointing us: "It is our desire not to limit your judgment in any way, and to ask you to report to us, what you consider absolutely the best method of increasing the traffic facilities, consistent with safety; and we would like to be advised what safety appliances are necessary in connection with the system you recommend."

Keeping this injunction constantly in mind, we have, in reviewing every plan presented to us, most carefully considered and investigated to what extent each contained elements, if any, of danger, especially those resulting from collision or derailment.

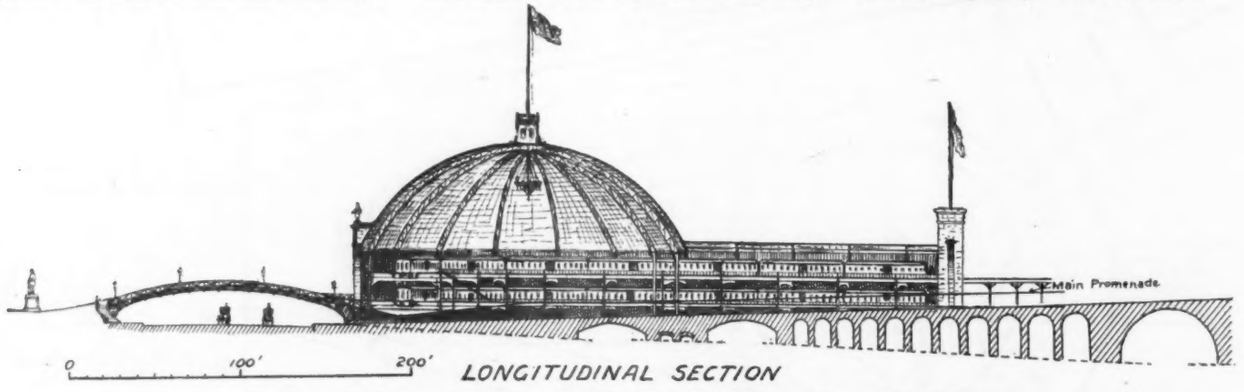


Fig. 3.—Rough Sketch of Section of suggested New York Terminus of Brooklyn Bridge.

Arranged to accomodate a second tier of cable cars whenever necessary. Similar Terminal in essentials to be erected at the Brooklyn end. Architecturally this sketch can be considerably improved. It shows also reconstructed bridge over Chatham street, and site for statue to NATHAN HALE on the present site of the Registry Building, his former prison. This sketch was made for the smaller (14-car) station originally suggested. The larger one (Fig. 2) extends to the first abutment of the Rose street arch, and extends downward to the dotted street line, the roadways passing inside of it. In that station also the lower cable track is on a down grade, nearly parallel with the roadway grade, the upper cable track is on a level or slight ascent, and the Manhattan elevated cars enter on a mezzanine or half floor between the two.

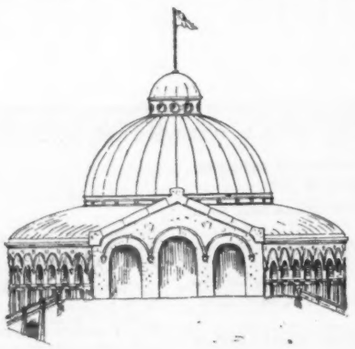


Fig. 4.

Rough Sketch of Rear End of the Smaller (14-car) Station, showing an alternate type of roof and dome construction, suggested to writer by Mr. WM. W. KENT, Architect.

[The rear view of the smaller station was selected only because more easily sketched. The rear view of the larger station, or the front view of either station, will be much more imposing and attractive.]

It is well known to and admitted by all practical railroad managers that among the many causes which produce derailments, by far the most prolific are those resulting, in many ways, from the use of switches, frogs and crossings; and notwithstanding the fact that their liberal use is an unavoidable necessity in the operation of surface railroads, it is the constant and most solicitous effort of every good railroad operator to reduce their use to the lowest possible minimum on lines of main track, and to place those that cannot be dispensed with in positions the least likely to cause danger, as also to guard them with every possible device to make their use safe, and to signal notice to approaching trains when they have been moved to positions menacing danger. Grade crossings of railroad tracks, especially on main lines, are also admitted by all railroad authorities to be especially dangerous. To emphasize this fact, it is only necessary to note the vast sums of money it is now deemed good judgment to expend in construction of new and in changing of old lines of railroad in order to eliminate their use, and in the now almost universal practice of providing the safety device of interlocking signals and throw-off or derailing switches, as a protection in the use of those which cannot be dispensed with, in order to discern what a very limited degree of absolute safety is really derived from the so-called safety appliances. Could anything be more convincing than the fact that in the use of the throw-off switch, used in the connection with the interlocking signals for grade crossings, should the warning signals be, either through negligence, design or other cause, disregarded, the alternative is the deliberate acceptance of the *minor* accident, of derailing the engine on the throw-off switch, in order to secure immunity from an impending *major* accident on the crossing. We are therefore unanimous, and most emphatic, in the opinion that under no circumstances should such devices be employed upon the tracks of the Bridge railway. They might, of course, be employed safely for a long time, but experience unerringly points to the inevitable accident, which, sooner or later, is sure to occur. We have, therefore, arrived at this conclusion as a cardinal principle: that if an arrangement of the New York terminal, and a system of

train operation can be found, commensurate with the maximum train capacity of the Bridge railway, preserving a continuous main track, unbroken by either switch, frog or crossing, that is unquestionably the one to be recommended for your adoption, and while it is manifestly impossible and unnecessary to encumber this Report with an extended recital in detail of all the reasons which have decided us adversely upon any of the plans included under the heads I. to III. inclusive, it may be desirable to state briefly the leading objectionable features contained in them.

I. The "Tail Switching" (present) system is objected to:

First.—Because its limit of platform length is for six cars only, without possibility of any further extension

Second.—It involves the very objectionable and justly inadmissible necessity of switching all trains

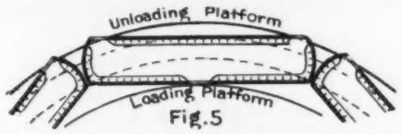


Fig.5

Fig.6

Arrangement of Car Exits and Entrances.

on a bridge over Chatham and Centre streets, almost to the Hall of Records, in shifting them from the incoming to the outgoing track.

Third.—In order to obtain sufficient length for six car trains, west of the west end of the station, it becomes necessary to extend the easterly end so far eastwardly, as to cause an unreasonable distance for passengers to walk, in going to and leaving the cars, and thereby create a tendency to inequality of loading in the several cars of the trains.

Fourth.—By thus extending the easterly end of the station so far eastwardly, the necessity of considerably raising its grade-level is created, owing to the steep gradient of the railway such extension is projected over; adding very seriously to the already sufficiently objectionable rise by stairs to reach the platform level from the streets.

II. The "Head House" system.

As this system cannot possibly be operated without the employment of a complicated system of switches, frogs, crossings and signalling apparatus, of more than doubtful efficiency, we are satisfied that it contains elements of danger, of a gravity sufficient to preclude its consideration, notwithstanding that in some other respects it may have desirable features.

III. The "Loop" system is objectionable:

First, because it requires the use of dangerous switches and frogs.

Second, it is limited in extent to trains of six or seven cars' length at utmost.

Third, it has the same objection noted in regard to system I., and common to any arrangement of station planned longitudinally east and west.

Of all the plans submitted to our review, the one alone which seems best to conform to the necessary conditions, is the simple "Circulating System," as represented in its general design by the plan offered by Mr. A. M. WELLINGTON, C. E., in which the objectionable features of all the others above referred to are eliminated. We have very carefully studied its adaptability to all conditions of the Bridge railway traffic, with the result of a decided and unanimous conclusion in our minds that the simple circulating system is unquestionably the one which best and most completely fits the conditions presented. We recommend that the diameter of the semi-circular loop be not less than 180 ft. (90 ft, center radius of the track), for the purpose of securing, *first*, ease of traction, and *secondly*, ample rotunda platform space, and while deeming it not properly within the scope of this report to enter into extended details of the line of investigation, and of the arguments which have led to this conclusion, doubtless it is proper that we should herein note some of the leading advantages which this system is found to possess, and which have had great weight with us in deciding upon it as the one to be recommended to you: they are:

First.—Safety in operation; for the reasons hereinbefore given.

Second.—Simplicity; making the railway an unbroken, circulating cable system, thereby eliminating the costly, noisy, inconvenient auxiliary locomotive terminal switching service, with its concomitant nuisances of noise, dirt, gases, cinders, dripping from water supply, etc.

Third.—Economy; in that it requires no expenditures for interlocking signal apparatus; switching engines, and the service and supplies of same.

Fourth.—The terminal station on this plan is confined, without the slightest disadvantage, to the easterly line of Chatham Street, thereby setting at rest, and removing the necessity for, the vexed question of the Bridge over Chatham Street and Centre Street.

Fifth.—It brings the Bridge trains nearer to the passengers and requires a shorter distance to be walked to reach the cars than is possible by any other plan.

Sixth.—It affords more spacious and commodious station and platform areas, and a greater number and ease of entrances and exits, that can be had on any other plan.

Seventh.—It admits of such a disposition of the cars of a train in the station, that all are of equally convenient access to passengers, thereby promoting equality of car loading in a greater degree than can possibly be obtained in east and west longitudinally planned stations.

Eighth.—It presents a ground plan of symmetrical shape and proportions, singularly well adapted for a superstructure of dignified beauty, and susceptible of a grandeur of architectural treatment in harmony with the majestic proportion of the great bridge structure, to which it should form a fitting climax, worthy of the two great cities it links together.

Ninth.—It is equally well adapted to the working of trains of any number of cars up to the maximum provided for, and can, without any very serious constructive difficulties, be erected around and over the existing station building, leaving it intact and in use, without much modification, until the new structure is nearly completed.

The maximum capacity of the Bridge railway can only be attained by increasing the number of cars per train to the limit most desirable in actual service (which experience in operating them alone can demonstrate), and in fixing the "headway" intervals as short as absolute safety requires for handling trains of increasing lengths. It is, therefore, obviously, true economic policy to make the cable plant, motive power and terminal facilities equal to that amount of train service. Such a terminal for the New York end, as to which alone we are instructed to report, is the one we now recommend, and we also recommend that if the existing cable plant and motive power is not adequate to that amount of duty, steps should be taken to ultimately increase it up to that standard.

In regard to operating long trains, we are decidedly of the opinion that in order to secure proper, certain and safe operation, a similar system should be adopted to that now accepted and practised as the best by all first-class surface railroads, under which it is found to be perfectly practicable to move trains of equal and much greater length and weight with entire safety, at speeds six times faster than the maximum found to be expedient for your train service, by placing the sole control of the train under one man at the head of the train. To accomplish this, we recommend that the leading car of every train should have a compartment fenced off at its front end,—or a separate small car may be attached to the head of each train,—constituting the counterpart of the Engineer's "cab" on an ordinary locomotive, in which shall be located mechanism for operating, by means of air pressure or electricity, the grips and brakes of every car in the train; such mechanism so reciprocally interlocked that the grips must be released before the brakes can be applied, and *vice versa*, that the grips cannot be applied before the brakes are released; and so mechanically arranged that the grips shall be released, and the brakes applied on each car consecutively from the rear to the head of the trains, and certainly not the reverse of this, from the head to the rear, as suggested by Mr. WELLINGTON. One guard or engineer to have entire control of the whole train, with an assistant near him in the "cab" as a precaution in case of sudden sickness, accident or

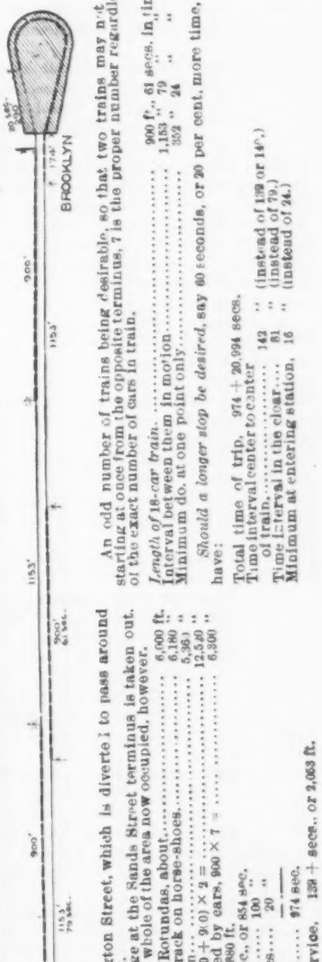

This train is just entering the station and has therefore the full 4 seconds needed for it to come, is about 20 seconds on y n the rea of the train ahead There is th refore no time when at least two-thir a of trac within the station is not occupied by cars.
BROOKLYN
This train is just starting, and in the act of applying grips and hence is 5 seconds ahe-d of the position it will have in motion.
NEW YORK

Fig. 7.

Diagram showing the Position of Trains on the Bridge and the Relative Proportion of Occupied and Unoccupied Track.

When Running 7 Trains of 18-Cars Each at 2 minute and 20 second intervals, or 126 cars in all in service.

In the off hours the same number of trains is continued in service, simply diminishing the length of each, first to 8 or 9 and then to 4 or 5 cars.

To illustrate that length of train has little real connection with ease of loading, the station is supposed to be divided by impassable partitions (except to let the cars through) into 3 equal stations holding 6 cars each, 1, 2 and 3.

The arrows represent the approximate position of the various separate station entrances proposed, each at least equal in width to the single entrance through which all passengers now pass, a passageway 20 ft. wide.

Fully two-thirds of Brooklyn re-idents live east of Bridge, Station 2, with 7 times the present entrance space. Takes passengers from the east. This traffic being all delivered into the common central space equalizes itself between 1 and 3. With an impassable partition between 1 and 3, the promenade sub-entrance only would still be equalized.

For stopping and starting, 5 × 4 secs. = 20 seconds is the difference in time of train makes no sensible difference, since the grip power is per car, and there are always six trains in motion for one starting.

The center of the Rotunda of the Brooklyn Terminus stands exactly on the present center-line of Washington Street, which is diverte i to pass around the circular end of the building.

The curvature in the bridge at the Sands Street terminus is taken out.

The new term nus includes the whole of the area now occupied, however.

Total Length center to center of Rotundas, about..... 6,000 ft.
" " track on horse-shoes..... 6,180 "
" face to face of station..... 5,361 "
" of track circuit (5,360 + 900) × 2 = ... 12,520 "
Fraction of do. occupied by cars, 900 × 7 = ... 6,300 "
Time required for round trip at 880 ft. per min., no stop, 14 min. 14 sec., or 854 sec.
Two stops..... 100 "
Stopping and starting, 5 × 4 secs.... 20 "
Total..... 974 sec.

Interval between trains, 7 in service. 129 + secs., or 2,063 ft.

An odd number of trains being desirable, so that two trains may not be starting at once from the opposite terminus, 7 is the proper number regardless of the exact number of cars in train.

Length of 18-car train. ..... 900 ft., 61 secs. in time.
Interval between them in motion..... 1,153 " 79 " "
Minimum do. at one point only..... 352 " 24 " "

Should a longer stop be desired, say 60 seconds, or 20 per cent. more time, we have:

Total time of trip, 974 + 20.994 secs.
Time interval center to center ..... 142 " (instead of 129 or 14'.)
of train..... 81 " (instead of 79.)
Time interval in the clear..... 16 " (instead of 24.)
Minimum at entering station.

other inability to perform his duties, as is now similarly provided by the second wheelman in the pilot houses of ferry-boats, and by the fireman in the locomotive cab.

Referring to your request "to be advised what safety appliances are necessary in connection with the system we recommend," we would respectfully state that in our judgment a complete system of block signals should be provided over the entire length of both tracks, with signal targets or semaphores erected at intervals of about the average headway length of the trains, operated automatically by the cars passing over "track levers," so that the guard in charge of every train will be at once signalled whenever the next preceding train has failed to preserve its proper headway interval, and also for the purpose of properly signalling and giving due notice, should necessity arise for reducing speed, or stopping trains, when approaching the terminal stations. There is no mechanical difficulty in devising such a system, as it would not differ materially from systems already in very successful operation on other railroad lines, and for which any competent signal engineer can prepare details and specifications. The actuating medium can be either hydraulic, electric, or mechanical, by simple levers, cranks and counterweights, as may be found most adapted, on study, to the special requirements of the Bridge railway and traffic.

We also strongly recommend that all trains be equipped throughout with the Westinghouse continuous automatic train brakes, operated from the leading "cab," as above described, and which can also be applied from every car in the train.

We are also decidedly of the opinion that an immediate modification in the present cable plant and grips should be made, that will provide the ability in any car to slacken speed, release and again pick up the cable at any and all points of its passage over the railway.

We transmit herewith a copy of Mr. WELLINGTON'S description, addressed to us, of his proposed plans and views, with its illustrative maps and diagrams, for the purpose of laying before you his own arguments in advocacy of it, for such consideration only as you in your own judgment deem them entitled to.

Finally, we desire to draw your attention to the fact that, should the time ever come when the maximum capacity of the present cable railway is exhausted with a still increasing demand for additional service, there remains to you the ability to construct an entire duplicate set of cable railroad tracks, carried on top of the present trusses, or over the roadways, or over both, as might be found most expedient in working out detail plans. These tracks would be admirably adapted for connections with the Brooklyn elevated railroads, and could be most conveniently accommodated with a "terminal" on a second story, above the tracks of the present cable railroad, in the same building recommended in this report, and into which the tracks of the Manhattan Elevated Railroad could also be conveniently taken, thus giving direct connection with the Brooklyn elevated railroad system, and enabling an entire removal of the present terminal station of the Manhattan Elevated Railroad over Chatham Street. And should the project of underground lines to the City Hall, New York, be finally decided upon, no better site for a "terminal" could be desired than that afforded by the space beneath, and enclosed by the foundation walls of the terminal station herein recommended; provision for which probable future requirements should be made in preparing the working plans for it.

All of which is respectfully submitted by

Your obedient servants,

The Board of Experts: { WALTER KATTÉ, *Chairman*, JULIUS W. ADAMS, JOSEPH CRAWFORD.

APPENDIX.

Report submitted to the Board of Experts, by Mr. A. M. WELLINGTON, M. Am. Soc. C. E., describing the recommended plan].

To Messrs. WALTER KATTE, JULIUS W. ADAMS, JOSEPH CRAWFORD. } Board of Experts New York and Brooklyn Bridge.

In accordance with your request the undersigned herewith submits the following abstract of what is, in his opinion, the best method of increasing the transit facilities of the Brooklyn Bridge.

It is believed that the truth must be faced at the outset that, as a not unnatural effect of the then existing conditions, the original expenditures for transit facilities were unduly skimped, and the arrangements then made entirely inadequate for permanent requirements, not only in one but in several respects. They were the last detail of the bridge to be studied, and seemed (and were) at the time a comparatively minor matter. The public impatience to have the bridge opened, and reluctance to spend more money, was great. The transit problem was an entirely new one, and its future magnitude hardly guessed at, as well as an entirely different one in its nature from that of bridge construction. It is not surprising, therefore, that there should have been some mistakes.

It will appear still less surprising if we remember that even now, with all the aid of experience, it does not seem to be generally recognized or considered that the existing facilities are inadequate in more than one respect, *car carrying capacity*, whereas they are, in fact, almost equally inadequate in respect to at least three fundamental requirements, viz.:

Requirement A. Car carrying capacity, as stated.

Requirement B. Means of entrance from the street to the outgoing platform, which is now of necessity through ticket gates at *one end* only of platforms constantly growing longer.

Requirement C. Means of approach from the streets to the station, which is now only by the sidewalks of Park Row and Nassau Street, which even before the bridge and New York Elevated Railway were built, were among the most crowded in the city, and have now become intolerably overcrowded.

It will be rather worse than useless to attempt to increase present facilities largely in any one of these three respects without increasing them in the other two respects correspondingly. It is, therefore, deemed a fortunate fact that the plan which, it is believed, will demonstrably give by much the largest car carrying capacity, a continuous circulating system of the type herein suggested, will also readily enable the facilities in the two other respects to be enlarged correspondingly, at comparatively trifling extra cost.

To the three purely utilitarian ends just specified should properly be added another, viz.:

Requirement D. Improvement in the architectural appearance and surroundings of the termini.

It is believed that both business judgment and proper self-respect should lead the people of New York and Brooklyn to regard the need for improvement in this respect as no less peremptory than in respect to the other three. The Brooklyn Bridge is the front door to the City of Brooklyn, which is a city seeking more tenants, and there are the same pecuniary motives for making the entrance to it commodious and attractive as obtain in the case of single buildings; but independently of this, "a decent respect for the opinion of mankind" and for the good name of two such wealthy cities should lead them, from mere self-respect, to make such a terminus of as fine architectural appearance as possible, even if there were no money in doing it, and even if the building stood by itself, instead of being a component part of one of the grandest structures in the world, which seems to demand more dignified appurtenances from a civilized people.

At present the whole terminal arrangements and surroundings are shabby and offensive to the last degree. Instead of being in any respect worthy of the structure, or even inoffensive, the combination of the wooden elevated station, contracted iron terminal shed, tunnel-like entrance to promenade, nondescript wood and iron bridge over Park Row; butting up against the shabby Registry building; together with the mud, dirt and crowd, the liquor saloons on each side of the terminal shed and the torrents of water which must be waded through in the rain, make it one of the most undignified and unpleasant localities to be found in any part of either city. This disagreeable effect has been added to lately by the wooden stairways which have been put in, and especially by the bracketed excrescences to extend the platforms over the roadway which have been added (of course necessarilly) to the present buildings, but have destroyed what little symmetry remained to it.,

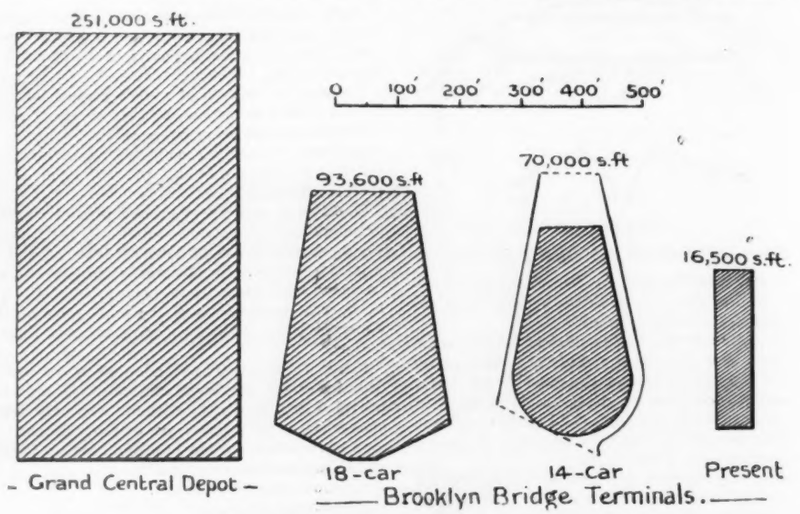


Fig. 8.—Relative Sizes of Terminal Stations.

[Into the 18-car Brooklyn Bridge Terminal it is proposed to run a maximum of 1,300 cars per hour of bridge cars only, and perhaps 800 cars per hour of New York elevated and under round cars in addition: equivalent to 300 trains of 7 cars each *per hour*. The Grand Central Station handles with some difficulty as many trains as this *per day*. This comparison will indicate that, while the space provided within the 18-car station is believed to be ample for all requirements, it is none too great an increase from the present station.]

PLAN PROPOSED.*

The plan proposed to meet ALL the conditions heretofore specified is in brief this: To spread the two cable tracks a little at each end and connect them by a horse-shoe curve of 90 ft. radius extending nearly to the street line of Park Row. The radius might be considerably shorter, as more fully pointed out below, except that it would not give a sufficiently commodious station for permanent requirements and decent architectural effect corresponding to the structure and location.

To erect a station similar to Fig. 2 herewith, to enclose under one roof the entire terminal horse shoe thus formed. A similar station in essentials to be erected at the Brooklyn terminus.

To run trains of 18 cars (less of course until all are needed) into this station, in a manner more fully described below, which when stopped, completely fill the station in horse-shoe form, with head and rear cars opposite each other.

* The plan proposed in the original draft of this report was for the smaller station shown in Fig. 1, extending no further east than the east line of the present building and accommodating only 14 instead of 18 cars, the extreme dimensions being 350 × 190 ft. with the roadway outside, instead of 434 × 288 ft. with the roadway inside. The Rotunda of the smaller station was only 100 ft. in diameter instead of 135 ft. The larger station, however, appearing to be for many reasons preferable, this description has been changed to correspond with it.

Entrance to train to be from inside platform only; exit from the outside platform only. The cars to have entrance and exit doors arranged in a peculiar way, to be shortly described, to facilitate quick loading and unloading on either the curved or straight track.

DESCRIPTION OF STATION.

The extreme dimensions of the proposed building are 434 ft. long by 288 ft. wide, of horse-shoe form. At the east end it terminates at the west face line of the Rose Street arch; at the west end at the sidewalk line of Park Row. The switching tracks which now extend halfway across the street are done away with. This station, although no longer than the present terminal, including the rear extension of tracks over Park Row, holds a train of 18 cars 50 ft. long, or 900 ft. in all with room to spare at each end; it can be arranged to hold 1,000 ft. of train. Ten of the 18 cars unload nearer to Park Row than at the present platform for three car trains.

The roadways are carried within the building in covered ways, as shown, 20 ft. wide, as now. This enables the toll gates to be under cover, and utilizes the space above the roadways as additional platform space for the upper tracks, where it is most likely to be needed. All the stone and brick work of the approaches west of the Rose Street arch are dispensed with and can be removed, except as they can usefully be made a part of the plans for the terminal building.

The building is widened slightly at the easterly end for the double end of obtaining desirable platform space, and bringing its side parallel with Frankfort Street. The entire small triangle of buildings between the bridge on the north, and Frankfort Street on the south, must practically be acquired, but besides giving ample room for the station, and enabling its side as well as ends to front on a street, the area will suffice to effect two highly desirable street improvements, viz., to widen Frankfort Street to 60 ft. from 35 ft., giving a new, wide street from City Hall to Franklin Square, and to give the necessary approach to the proposed new street between Nassau and William Streets by cutting off a triangle where French's Hotel now stands. The total cost of all the land now owned at the terminus, which included the old *Staats Zeitung* building, was under $500,000. Assessing a proper proportion of the cost of the land on the property benefited by the street improvements, it is believed that $500,000 should cover the cost of the additional land properly chargeable to the terminus.

The station terminates at the west end in a large rotunda, which is the principal feature of the building. This rotunda is bounded on the outside by an iron fence to the loading or outgoing platform, and this fence is continued parallel to the track along the entire 900 ft. of track within the building. In this fence are placed 18 or more ticket wickets approximately opposite to the central entrance door of each car, the windows for sale of tickets being at some interior point.

By these arrangements the entrance to the outgoing platform is from the *side* at all points instead of from the ends only (see Fig. 7),—a very important and radical distinction which at once removes all those difficulties in getting a large crowd of passengers through the wickets to the loading platforms, which must always exist in any form of end entrance to long platforms. There remains only the difficulty in getting them from the streets into the interior space, amply provided for below.

The diameter of the rotunda, etc., is roughly as follows:

Rotunda proper, constituting the beginning of promenade, as well as an entrance space for car passengers, and bounded on the outside by fence to outgoing platform	135 ft.
Center line of track	180 "
Outside of Incoming Platform, at center of rotunda	220 "
Outside of Roadways	260 "
Extreme width of building, west end	288 "
" " " east end	163 "

The rotunda should be entirely open space, unless for some central news stand or ticket-selling booth, with free access to it from all street entrances. The promenade starts from it on the same level and extends east through the center of the building, but it does not necessarily nor preferably become a distinct feature of the station, so as to separate the promenade from the car passengers, until near the east end of the station, especially if promenade tolls are to be abolished, as seems probable. The large central space will afford needed room not now existing nor obtainable for elevators and stairways from the three streets which pass directly below the station, but which are now entirely useless as means of entrance from lack of any central space in the station to provide for such entrance. It will also provide ample and needed space for waiting and parcel rooms, news and cigar stands, lavatories and water closets, light refreshments, and offices of various kinds, as well as for stairways and elevators to the upper tracks suggested below, when and if constructed.

With any ordinary skill in design, such a building can hardly fail to be a stately and dignified structure, and at a moderate cost, in the hands of good architects, it can be made one of the finest terminals in the world, in broad contrast to the shabby arrangements which are now made here and elsewhere for rapid transit.

Figs. 3 and 4 are rude and hasty sketches giving a general idea only of the capabilities of the plan. A higher roof east of the rotunda may be preferable.

HANDLING OF TRAFFIC.

As the 12 to 18-car trains shown in Fig. 2 enter it, the leading cars drop the cable in succession, or simultaneously (the rear ones still keeping hold) and sweep through and around the horse-shoe curve at precisely cable speed until the head of the train is within two or three car-lengths of the end of the south arm of the station.

Then for the first time the whole train drops the cable, and the air brakes are applied, bringing it to a stop in the position shown.

[This is on the assumption that the cable is not to pass around the horse-shoe curves direct as will probably be expedient. If it does, the cars will all release and grip the cable at once.]

It will not be expedient with such long trains to have independent brakes on each car. They must be applicable to the whole train from any point, as in general railway practice. It is desirable also that the grips should be rearranged, *first*, so that they may be applied, released and applied again at any point (instead of at the termini only), and *secondly*, to work by air, inter-dependently with the brakes, by the same brake-handle and valve, so that moving the brake-handle to one side releases brakes and applies grips, moving it to the other releases grips and applies brakes, etc. A single man on any car can then handle the whole train by one brake-handle, and any passenger on any car can stop the whole train in an emergency, as on other railway lines. The necessary appliances to this end are simple and entirely practicable, and will make the handling of 18 or 20-car trains both simpler and safer than the present system for 3-car trains, which has a certain unavoidable element of danger in it, (1) from the confusion resulting in dropping back to the station to resume the cable after once dropping it, and (2) in the resulting fear of dropping the cable at the first sight of danger, or until it is seen to be absolutely unavoidable, when it may be too late.

Switching and switching engines are entirely done away with by this plan, and all expenses therefor are saved.

Five engines and four crews now constantly employed are thus released, saving at the lowest estimate $100 per day, or $36,500 per year, which is interest at 3 per cent. on over $1,000,000. All expense for interlocking apparatus is likewise saved, since there are no switches to interlock. The total direct and indirect expense for switching is fully $50,000. These savings alone should far more than pay interest at 3 per cent. on the entire cost of carrying through the improvements suggested herein in thoroughly good shape.

But the improved system of handling trains and grips will also make possible a very large economy in cost of train service over present methods. The preferable arrangements will be these: 18 platform men at each terminus, one for each car, will open and shut all the doors at once as each train arrives and departs, and guide and instruct the passengers. *Three* trainmen only, one at the head, one at the rear, and another merely ornamental and precautionary, will handle each train. Again, no trains are out of service switching, whereas now there must be two trains more at each end, one loading and one switching, while a third is unloading. *Seven* trains will therefore do the same work which would require 11, by a mere expansion of the present switching system. To run 18-car trains at 2½ minute intervals by present methods would require a force of at least 229 train and platform men, whereas with the circulating tracks and better grip and brake system 57 only will be required to give a better service, as thus:

	No. of Trainmen.
PRESENT SYSTEM EXPANDED: 11 trains in service (7 doing the work, as per Fig. 7, and 4 constantly out of service switching), with 19 trainmen for each 18-car train	209
Platform guards, say only 10 at each terminus	20
	229
PROPOSED SYSTEM: 7 trains with 3 trainmen each	21
8 platform doormen at each terminus	36 57
Saving in employes (over 75 per cent.)	172
Seats per train-hand, present system (expanded to 18-car trains), 18×42×7÷229	23
Seats per train-hand, present system (3-car trains), about	20
Seats per train-hand, proposed system, 18×56×7÷57	124

In other words, each train employé will have more than six times the transporting efficiency that he has now. At $45 per month each, this represents a saving of $92,880 per year over a simple expansion of the present system of handling trains, allowing such expansion to be possible.

As part of the train at least is always over the cable, the train can be moved slightly within the station or started at any time, in any position. Should a car be disabled, it is uncoupled from the rear cars, the head of the train grips the cable and pulls out a sufficient distance, and then the disabled car is dropped back by gravity on to the "disabled car switch" shown below the south track. The head of the train then drops back by gravity and couples on to the rear of the train, and the whole train proceeds.

The car may be repaired on the siding and taken out in a similar way, or an engine sent around after it.

This disabled car switch, and a corresponding one at the Brooklyn end, are the only switches in the whole track. As they are rarely used, and hence can be readily arranged to make no break in main rails whatever, either for frog or switch, they can only become a source of danger by gross carelessness, making this plan far safer than any other can be in that respect.

The number of trains in service should remain always the same (7) in both rush hours and off hours. The full number of cars, say 12 or 20, is run only during the two rush hours (see traffic diagrams). When these are over, half the cars are uncoupled from the rest, just before entering the Brooklyn terminus, held back a couple of car-lengths by the brakes, just long enough to throw a switch, and run out to the present storage tracks by gravity, where they are carefully inspected. An hour or so later, half of the remaining cars are run out of service in the same way, leaving only a quarter of the cars in each train in service for about 14 off hours of the 24. The cars are put back into service in the same way, as the rush hours approach, by a single switch engine kept on hand for that purpose and for emergencies, or they may be put into service as well as out of it by gravity.

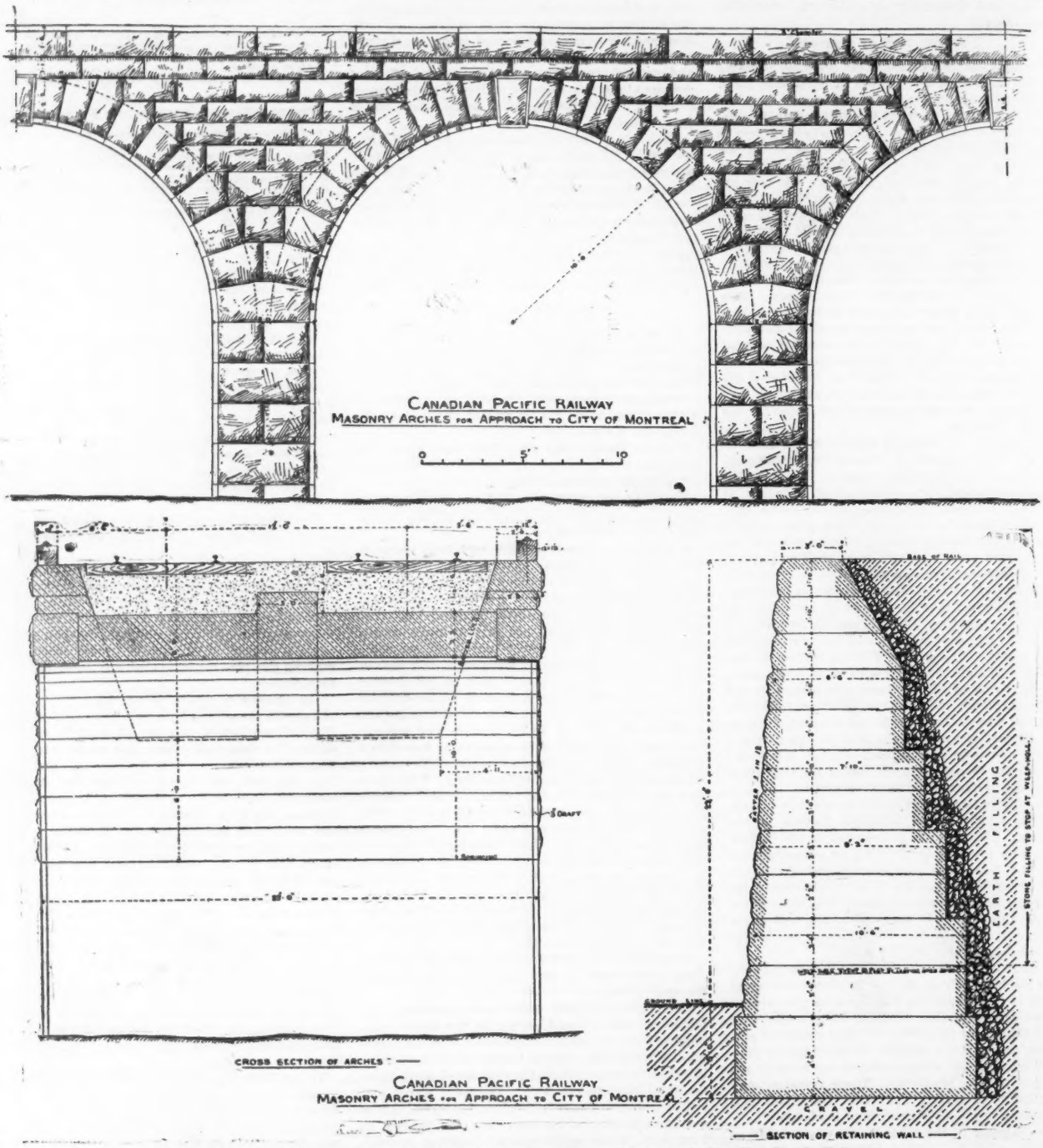
This process is a perfectly simple one, and need not delay the routine of train service by a second. The average time of service for each car is only 10½ hours per day, leaving ample time for inspection and repairs.

To facilitate the above method of operating, and for other reasons, it is desirable to have the tracks of both termini on a down grade within the station, bringing them but little more than half as high as now above Chatham Street sidewalk on the New York side, and nearly at the level of the sidewalks at the corner of Washington and Sands Streets on the Brooklyn side. The horse-shoe form makes this possible, for whether the plane of the horse-shoe track within the building be a level or on such a down grade, a train standing on it in the position shown starts from it, mechanically, as from a level grade. It is the locus of the center of gravity of the train which fixes the equivalent grade under these unusual conditions; the dip which hinders one-half of the train helps the other. By having the north track (at New York) slightly higher than the south, or by having the train stop with more cars on the north track than on the south, the train will start as from a down grade. This will be seen more clearly by imagining the horse-shoe curve developed into a straight line. The station as a whole, therefore, may have a very decided dip against starting trains,

and yet trains start with the equivalent of any desired favoring grade, by making the north arm of the horse-shoe higher, or the south arm lower.

The rotunda should be made level. It may be desirable to have a slight down grade on the horse-shoe curve, in order to balance its extra resistance as nearly as may be, and give a perfectly smooth motion around it; but this need be but slight.

(CONCLUDED NEXT WEEK).


CANADIAN PACIFIC RAILWAY
MASONRY ARCHES FOR APPROACH TO CITY OF MONTREAL
0 5' 10'
CROSS SECTION OF ARCHES
CANADIAN PACIFIC RAILWAY
MASONRY ARCHES FOR APPROACH TO CITY OF MONTREAL
EARTH FILLING
GRAVEL
SECTION OF RETAINING WALL

Arches and Retaining Walls for Viaduct Approach to New Montreal Terminal, Canadian Pacific Railway.
P. ALEX. PETERSON, Chief Engineer.

Montreal Terminus and Viaduct Approach, Canadian Pacific Railway.

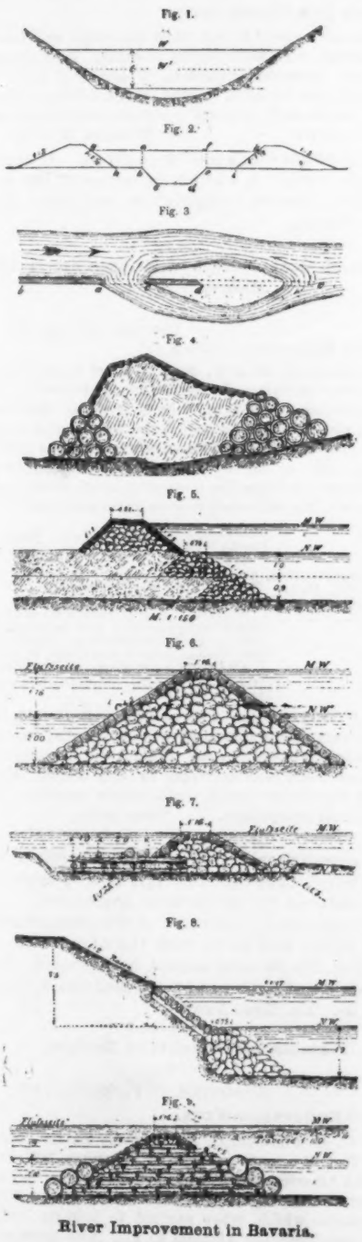
We complete our illustration of this fine work, a general view of which was given in our issue of March 3, by detail drawings of the arches and retaining walls. Each will be seen to be of solid and durable proportions, in view of which the comparative estimate which we published March 3, showing that the total cost of the stone viaduct was only $92 per lin. ft. as against $77 for an iron viaduct, and that the total estimated cost per foot per year for maintenance and interest charge was only $4.75 for stone against $5.05 for iron, carries a moral which it is needless to enlarge upon. It is greatly to be desired that this class of works for entering our great cities should be multiplied, for the sake of safety, speed, comfort and economy alike, and the late widespread blizzard seems to make it a particularly favorable occasion for pointing out that the better way of entering a city with railway tracks is in all cases *above* the streets, and not below them, wherever possible. If economy alone were more considered, there would be many more such approach tracks completely separated from the streets. The annual extra cost at 4 per cent. interest is $92 × 0.04 = $3.68 per foot per year or as nearly as may be *one cent per foot per day* or $105.60 per day for two miles of track. This seems to be, and is, a considerable sum, but when the saving in gates and flagmen, maintenance of track, interference with switching, trouble with snow and ice, and occasional damages for accidents are considered on the one hand, and the increased passenger traffic, which always results, on the other hand, especially of short trip and suburban traffic, it requires only a very moderate trunk line traffic to make it a paying investment from a purely pecuniary stand-point, which is not a proper one.

SOME experiments are being made in the use of electric lighting apparatus on German railways. The cost varies from 62 to 88 cents per light of 12½ candle power per hour, based on an average use of 2100 hours per annum. At these rates it is evident that great improvements must be made before electric train lighting can be generally introduced.

River Improvement in Bavaria.

The following matter upon river correction in Bavaria, is condensed from a lengthy article in the journal of the Austrian Society of Engineers and Architects, No. 43, 1887:—

After treating of the purpose of river improvement, the author lays down a few general rules to be observed; the convexity of the banks, shallow places, islands, etc. must be utilized in the general plan; mountain streams should not be carried directly down the hill-sides unless the only purpose is to drain a marsh, usually the descending gradient should be made as light as possible by long and winding channels. When the river to be improved runs at the foot of a hill containing springs, the stream should be moved out as far as possible towards the valley, so that the area watered by the hill streams may be increased.



River Improvement in Bavaria.

One of the difficulties met with in dealing with mountain streams is the establishment of a proper proportion between the depth and the width of the channel at the lowest water line. The rule recommended in this case is as follows:—The fall, volume and velocity being known, this proportion is found by the formula

$$n = \frac{F}{\left(\frac{W \pm \sqrt{W^2 - 4\,a\,F}}{2a}\right)^2}$$

In which (see Fig. 1) F is the surface profile, W is the surface width and a = cot. α = the inverse ratio of the slope. In a like manner n is calculated for various profiles. To find the proper n we have the formula

$$V = K\sqrt{R.J.}$$

in which K has been previously calculated for certain velocities. Then $t = \frac{b}{n + a}$, in which b is the normal width of water surface. The wetted perimeter is

$$p = \frac{b\,(n - a + 2\sqrt{1 + a^2})}{n + a}$$

and the surface is

$$F = \frac{b^2 . n}{(n + a)^2}$$

Therefore

$$R = \frac{b . n}{(n + a) . (n - a + 2\sqrt{1 + a^2})}$$

Trial values are taken for b and n and v are calculated from them until it is found that $F \times v = Q$, the volume of water to be dealt with. With b and n known, the depth t is also known. The proper width of channel for mean water, full stream and high water can then easily be found; either by simply adding the known difference of level for low water to the one sought, or from the figures based on the general gradient of the ground and the known velocity.

When flood water is to be carried away between dykes, as in Fig. 2, the distance between the banks is found as follows:—First, find what volume will pass off in the area $a\,b\,c\,d\,e\,f$; the remainder must pass away through the sections $g\,h\,b\,a$ and $f\,e\,i\,k$. In calculating the width of these last it is assumed that together that they form a trapezium, though the width may be unequally divided between the two banks.

In closing up a side channel encircling a bank of gravel (Fig. 3) the portion c, d is first completed and then the channel from a to c is filled with stone or wattled piles and the work continued from d to c. When the filling of such a gap is a continuance of a gravel embankment, parallel walls of loose stone, or bundles of fascines as in Fig. 4, must be first put down. These wattles must be filled with stone on the river side, but gravel will do towards the land.

In large rivers no openings are made in the side training walls as a rule. The opening in works for regulating mountain streams are usually from a fifth to a sixth of the normal breadth of the channel, and are always located below the training wall. In such openings the bottom is covered with wattle piles or fascines laid parallel with the current.

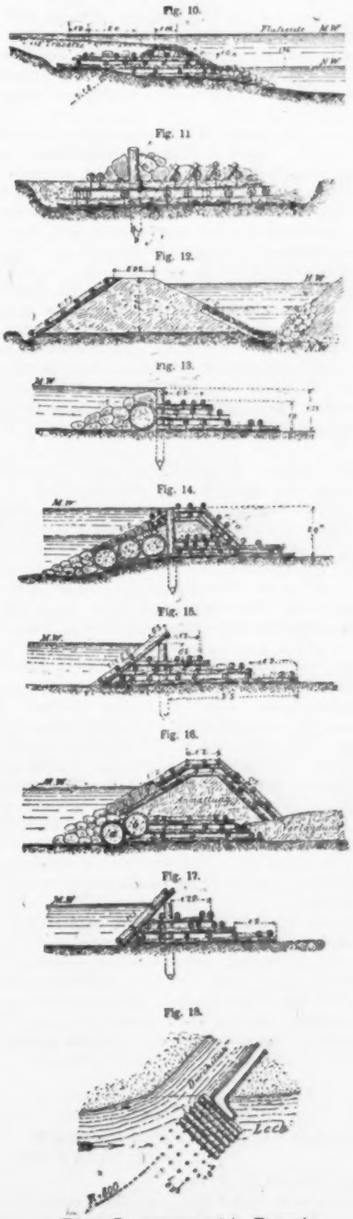
In training walls of stone, parallel to the stream, the crest is made about 40 ins. wide; the inner side is generally planted at the foot of the slope with willow twigs, or fascines capable of sprouting are put in the face of the wall. The river slope of such walls is 1 to 1½ and the inner slope at least 1 to 1. The crust and slopes are paved to a depth of 12 ins. with stone. The general arrangement of such a training wall is shown in section in Fig. 5. In Figs. 6 and 7 are seen other types of stone training walls as used on the river Inn: one of these for use on concave and the other on convex banks.

In training walls of fascines with stone covering the crest varies in width from 40 to 70 ins. The fascine work always extends above mean water level, and when the current is a strong one the river slope and the crest are covered to a depth of 2 ft. with stone, and this covering is finally paved. If the slope below low water is not made with fascines, the slope on the river side is made 1½ to 2 and on the land side ½ to 1½. Under low water the small ends of the fascines point outward; above low water the butt ends appear.

From Ulm to Donallwörth, on the Danube, these training walls are divided into two independent portions; *i. e.* the face and the rear construction. The face is made of gravel filled fascines laid down in the shallow places first; but in deep water the back portion of ordinary fascine work is first built and stone then piled in on the river side and on the crest if necessary. Below Donallwörth the rear part is built of fascines to low water and the remaining part of stone. On the Idler and Lech the fascines are destroyed by the grinding action of coarse pebbles and on account of the cold water can not sprout.

Figs. 9 and 10 represent walls on the convex and concave banks of the Inn, from Rosenheim to Lower Bavaria. In these walls fascines are first laid down to a point about 3 in. above low water and temporarily loaded with stone; when the silting occurs on the shore side the stone is removed and the fascine work raised 42 in. above low water and then loaded again with stone. When the material is well compacted the river slope and crest are both paved. The upper fascines are usually allowed to sprout so as to protect the filled in ground behind the wall.

On the Isar we find training works of fascines filled with gravel crowned by fascines filled with stone. On the river side the slope is protected with



River Improvement in Bavaria.

stone from the bottom to mean water; above this is a filling of gravel. The two slopes and the crest are covered with double layers of fascines. The crest is 40 in. wide and the outside slope 1½ to 1 and the inside 1 to 1. Figs. 13 and 14 show this type as applied at Lech, with the addition of a center row of piles. At Landsberg the base is formed of wattled and packing fascines as shown in Fig. 16.

Fig. 12 shows a training wall of gravel with stone facing. The crest is 40 in. wide with a front slope of 1½ to 2 and a rear slope of 1 to 1½.

Fig. 15 and 17 show sitting cross walls, as used at Landsberg and Scheuring on the Lech. The front is made of a layer of fascines, with packing fascines behind and anchoring piles. Fig. 11 shows a similar traverse wall loaded with stone, as used on the Inn.

Fig. 18 shows a plan adopted on the Lech for deepening a side channel by cutting out the channel bed and protecting valuable lands from overflow by the consequent lowering of the general surface. The protecting works are simply bundles of fascines anchored by piles as shown.

In the diagrams accompanying the article the designations *M. W. N. W.*, and *H. W.* signify mean, low and high water.

CORRESPONDENCE.

Nomenclature of Hydraulic Cements.

University of Illinois.
CHAMPAIGN, Feb. 24, 1888.

EDITOR ENGINEERING NEWS:

There is great diversity and some confusion in referring to that other cement, which is not Portland. In the specifications for one of the largest bridges completed in the West during the past year, it is stated that "the mortar shall be composed of the best hydraulic cement;" it was certainly not the intention to require the use of Portland, nor was it used. That other cement is frequently referred to as natural, or American, or domestic, or imported. The term natural does not seem appropriate, for no one cares whether the cement is obtained by burning a natural limes one, or by mixing half a dozen varieties of limestones, clays, etc. The term American or domestic does not seem appropriate, since there are already several manufactories of Portland cement in this country, and no good reason can be assigned why there may not be many more, as there probably will be ere long. All imported cement is not Portland, nor is all the Portland cement in use imported. What then shall we call the other cement?

Portland cement is usually so called because first made on the isle of Portland, off the south coast of England. Pozzuolanna is the name quite uniformly employed to designate the cement obtained from volcanic ashes and used by the Ancients; the name is derived from Pozzuoli, the name of the Italian village, near the foot of Mount Vesuvius, where first discovered. Now, since that other cement was first discovered in the town of Rosendale (N. Y.), and since at present about one-half of all that class of cement made in the United States is made near that place, it seems only proper that cement, which, as compared with Portland, is light and quick setting, should be called Rosendale.

Cement of this type can then be referred to as Milwaukee, or Louisville, or Akron, or Ulster Co. Rosendale; we can also have South Bend Portland, Pennsylvania Portland, and Denver Portland or Denver Rosendale, etc. This will also do away with the ambiguity of such phrases as "quick setting cement," if we mean one thing, we will say quick-setting Rosendale, and if we mean the other, we will say Rosendale.

Uniformity in this matter would be beneficial. Thererore I propose that, if you approve, you publish this, and invite engineers to send you on a postal, together with their name and title, their choice as the name for that other cement. When the returns are in you can sum the whole matter up and give us the name having the approval of the best authorities. Yours truly. IRA O. BAKER.

Strains in Pins.

Dep't of Civil Eng., Washington University.
ST. LOUIS, March 6, 1888.

EDITOR ENGINEERING NEWS:

In your issue of the 3rd inst., appears a communication from Mr. J. E. BUDDINGTON on the subject of "Fiber Strains in Pins." He says it is the problem of the continuous beam. It is probably a sufficient answer to say that in the problem of the continuous beam or girder, the supporting forces are unknown, and can only be found after the bending moments are computed. In the case of a pin, carrying eye-bars with known stresses, the case is quite different. The external forces here are all known, and the moment at any section is simply the sum of the moments of all the external forces on one side of that section, about a point in the section. This summation is easily found, the most convenient form probably being that given by Mr. FRANK C. OSBORNE in your issue of Feb. 18th.

As to Mr. BUDDINGTON'S equations, they are meaningless. Taking his figure, on page 161, if he wants to find the moment at P_3, he should write.

$M = P_2\ (a_1 - a) - M_1$ instead of

$M = P_2\ a + P_3\ a_1 - M_1$ as he has it.

Furthermore, when all the forces are known in position and amount, his function $2\ L$, which he introduces has no significance, it being no function of the problem. In other words, Mr. BUDDINGTON has used the wrong equations, in the wrong manner, and on the wrong assumptions.

J. B. JOHNSON.

[We trust that a sufficient amount of data has been spread before those of our readers interested in strains in pins to enable them to sift out definite conclusions for themselves. Even good engineers will disagree on some very important points of practice; but after they have expressed their differences of opinion and the reason therefor, an attempt to convince the "other fellow" against his will is likely to lead to endless controversy, for which we neither see occasion nor can spare the space.—ED. ENG. NEWS].

Curve Compensation.

DENVER, Colo., March 9, 1888.

EDITOR ENGINEERING NEWS:

Being somewhat in the dark on a couple of subjects connected with curves I wish to ask a question or two.

First as to compensation: On the Denver & Rio Grande Railway the rate of compensation is 0.04 per station, per degree of curve. My attention was not long ago called to the fact that passenger trains invariably quickened on a curve when running up grade. This quickening was noted sitting in a car or on a platform, and was apparent to the senses. Not long since I had an opportunity to ride on a freight train well loaded, the train being sixteen cars, thirteen of them loaded, two light, or only partially loaded and one a caboose. Judging by the exhaust of the engine and by my sensations I would say the train always quickened on the curve and lost on striking the tangent, although the latter was much less perceptible. But this seemed to be the reverse in one instance, where we were just starting from a station and had not gained momentum. I have somewhere read a discussion on this subject in which the ground was taken that it was necessary to use much less compensation where the speed was high than near stations where it was low. Is there any established custom on this head?

Again on curves, an old and experienced railroad superintendent has said that a reasonable amount of curvature rendered riding at high rates of speed more safe; that on a tangent a train was liable to oscillate to a dangerous degree, but that a curve steadied the train, provided the curve was properly eased and elevated. Riding on a train load of ties I noticed that the ties shook loose and out of place only on tangents, and settled on curves. Ties were piled crosswise of the car. I do not advance these ideas as proving anything, the last was a new one to me and my observation has tended to support it. It is directly contrary to what I have been taught, but may not even curves have merits?

DIV. ENGINEER.

[It is altogether probable that a continuous *easy* curve, say 1° or less, is a positive advantage to the riding of trains as compared with a tangent. The power lost is slight, while the wheels have a constant tendency to the outside rail instead of no tendency to either, greatly conducive to steadiness of motion. A test some years ago made by painting the inside head of the rails showed that the wheels on *that* tangent at least took very nearly the path of a series of reversed 2° curves having a middle ordinate equal to the play of the guage. But the curve takes more labor to keep up, and is otherwise objectionable. We are not advising putting in curves for the fun of it.

It is not only probable but almost certain that curve resistance is lower at high speeds than low speeds, and lower *per degree* on sharp curves than easy curves, for reasons set forth in Chap. VIII of the "Economic Theory of the Location of Railways," from which our correspondent has probably derived his impression. The rate of 0.04 is probably excessive for the higher speeds on sharp curves, but not for easy curves. The senses are very deceptive as to speed of trains. ED. ENG. NEWS.

A Supposed Omission.

ROCHESTER, New York, March 15, 1888.

EDITOR ENGINEERING NEWS:

In your issue of March 10, in an article on "Load Diagrams for Determining Stresses in Railway Bridges," reference is made to "Polygons *A* and *L*."

Was it not intended to give an illustration of the polygons as well as of the scales to which they are to be drawn? WILLIAM E. HOYT.

[All the drawings sent were given. If omitted, the omission was not on our part, but we shall be pleased to supply the omission. ED. ENG. NEWS.]

Time of Construction of Bridges across the Missouri River.

CHICAGO, Feb. 23, 1888.

EDITOR ENGINEERING NEWS:

In your issue of 17th, inst., appears a tabulated statement showing the dates for commencing the construction of certain bridges over the Missouri river, also the date on which the first engine went over, and the number of days required for the work. In the case of the Plattsmouth, Blair, Bismarck and Omaha Bridges this statement is erroneous, and I give you the following correct dates and time.

	Construction begun bridge proper.	First engine crossed.	Days elapsed.
Plattsmouth, Neb.	Aug. 9, 1879.	Aug. 27, 1880.	383
Bismarck, Dak.	May 12, 1881.	Oct. 18, 1882.	524
Blair, Neb.	Sept. 19, 1882.	Oct. 27, 1883.	403
Omaha, Neb.	Replacing single track with double track bridge having new foundation and new superstructure. Work begun bridge proper about Oct. 15, 1885. All trains were kept running during construction. Double track put in Oct. 1, 1887.		

In reference to the Omaha bridge it should be stated that this is a double track bridge, and during its entire construction the bridge was in constant use and there was no delay to any trains. This use of the bridge during construction considerably delayed its completion. Yours truly,

E. L. CORTHELL.

[A comparison with the table referred to in the above shows that the time is very materially reduced in the present statement. As Mr. CORTHELL is a member of the engineering firm which had to do with the above named bridges, his figures cannot be disputed. In our article of February 18, we used the figures sent us. ED. ENG. NEWS.]

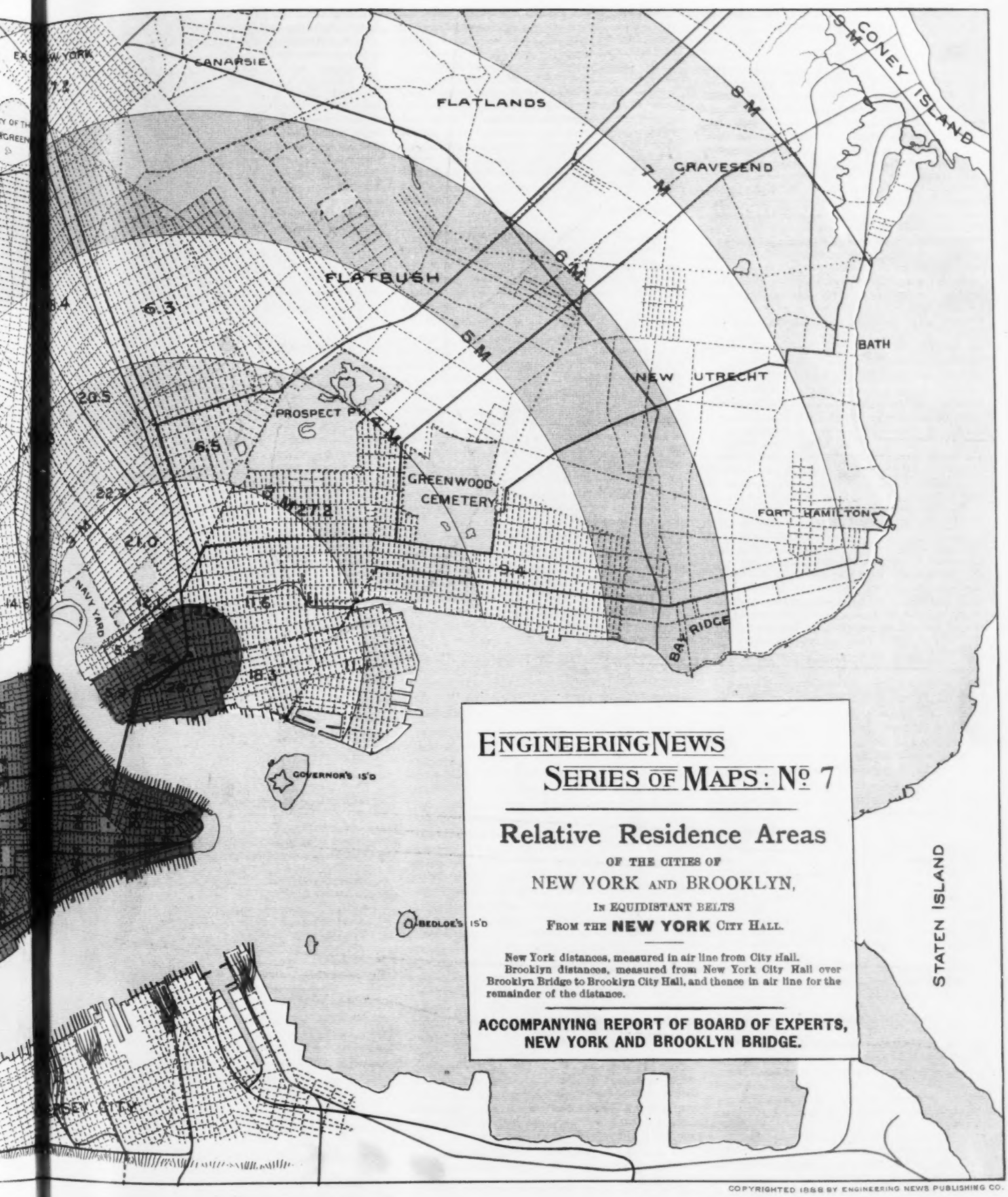
Formulæ for Weights of Bridges.

ROCHESTER, N. Y., March 9, 1888.

EDITOR ENGINEERING NEWS:

Mr. G. H. PEGRAM, C. E., formerly of the Edge Moor Iron Co., gave a paper in February, 1886, before the American Society of Civil Engineers, on the subject of the weights of bridges, and gave a series of formulæ which, when applied to bridges built under specifications kindred to his, gave good results. He applied his formulæ, with great thoroughness, to nearly all classes of bridges except through plate girders having an iron floor system of floor beams and stringers, a type of structure now being built for a great many roads, both in the east and in the west. I applied Mr. PEGRAM'S formula to the case of certain bridges of that class, which were recently built, and found that lighter weights were given by the formula than had been found by weighing the bridges in question. This disagreement was to be expected, since the specifications under which the bridges mentioned had been built, necessitated the use of more material than his. As the specifications in question are fairly representa-

CHAS. HART & SONS, LITH. 36 VESEY ST. N.Y.



ENGINEERING NEWS
SERIES OF MAPS: No. 7

Relative Residence Areas

OF THE CITIES OF

NEW YORK AND BROOKLYN,

IN EQUIDISTANT BELTS

FROM THE **NEW YORK** CITY HALL.

New York distances, measured in air line from City Hall.
Brooklyn distances, measured from New York City Hall over Brooklyn Bridge to Brooklyn City Hall, and thence in air line for the remainder of the distance.

ACCOMPANYING REPORT OF BOARD OF EXPERTS, NEW YORK AND BROOKLYN BRIDGE.

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tive of those now being adopted, I thought the results might be interesting and, perhaps, of value to some one else, and accordingly give them below.

The live load consisted of two 86 ton engines on a wheel base of 52 ft. each, followed by a freight load of 3,000 lbs. per lin. ft. of track, or very nearly the same as Engine Loading No. 5, of the Keystone Bridge Co. specifications. The unit strains were 7,000 lbs. per sq. in. in the compression flange, 8,000 lbs. per sq. in. in the tension flange, next section; shear in the webs, 4,000 lbs. per sq. in.; shear on rivets, (nominal section on area of rivet before upsetting to be used,) 7,000 lbs. per sq. in.; bearing on rivets, 12,000 lbs. per sq. in. For the floor system, allowance for impact is made by adding 25 per cent. to the live load. In the main girders the live load strains were increased as in the following table:

For girders 30 ft. long and under, - - -	25 p. c.
" 30 ft. to 50 ft. long, - - - -	20 "
" 50 ft. to 75 ft. long, - - -	15 "

The safety stringers were assumed to carry one-half the load that a main stringer carries.

I took Mr. PEGRAM'S formula

$$W = \left(75 + \frac{s}{7}\right) s \sqrt{s} + 200\,s + 100\,s$$

in which W = the shipping weight of the bridge; s = the distance center to center of bearings; $200\,s$ = allowance for iron floor system; $100\,s$ = allowance for safety stringers. Starting with this form of expression as a basis, I made several trials to find what values the constants would assume, in order that the resulting formula should give results, closely checking the actual weights of the bridges in question. The following formula was the result:

$$W = \left(77 + \frac{s}{4}\right) s \sqrt{s} + 400\,s + 100\,s.$$

Applying this formula to the bridges referred to, I obtained results as given in the following table:

Through Plate Girders, Two Lines of Safety Stringers.

$$W = \left(77 + \frac{s}{4}\right) s \sqrt{s} + 400 \times s + 100 \times s.$$

s = distance center to center of bearings.

s	Shipping Weight by Formula.	Actual Shipping Weight.	Per cent. Variation.
Feet.			
30.6	29631	29990	− 1.2
36.33	37025	36505	+ 1.4
39.33	41077	40240	+ 2.1
45.33	49615	50280	− 1.3
48.33	54087	54370	− .5
56.33	66701	67536	− 1.2

The per cent. of variation is figured on the actual shipping weight as a basis.

The allowance for safety stringers, computed on the assumption given in the specifications, I found to be correct by making a large number of comparisons, the actual weights only varying one or two pounds on either side of the figures assumed in the formula.

I would make, however, this modification: I think the allowance will not hold for panels in excess of 14 ft. For panels longer than this the weight per foot for safety stringers increases. In one case that I have in mind for a panel of 16.7½ ins. the weight per foot of safety stringers was 135 lbs.; but as the panels for through plate girders hardly ever run over 13 or 14 ft., I think the allowance will be found correct. Yours sincerely,

ALFRED M. MOSSCROP.

[We have a highly interesting communication and diagram from Mr. PEGRAM which will appear shortly, and which will be of interest for comparison with the above data, although it applies chiefly to bridges of larger span.—ED. ENG. NEWS.]

Wrought-Iron Piles vs. Sea Water.

BLACK RIVER FALLS, Wis., March 2, 1888.

EDITOR ENGINEERING NEWS:

In your remarks following PETER C. HAINS' letter, did you not make a mistake in saying that iron piles in Delaware bay corroded more "below" low water? Should it not read "above"? I have noticed that iron structures of all kinds were rusted away the most between high and low water. And as this process is simply an oxidation, and not the formation of chlorides, it stands to reason that this would be so. The water excludes the oxygen of the air when the metal is entirely submerged in it; but when wet and exposed to the atmospheric oxygen, oxidation goes on more rapidly. While the presence of chloride produces no chemical combination with the iron, it seems to increase the action of the oxygen. The formation of a coating of shells, I have noticed sometimes protects the iron *above* low water, and sometimes nearly up to high water. Steel stands the action of sea-water much better than iron. Yours respectfully,

A. S. COOPER.

[In the paper quoted by us, on Feb. 25, Mr. PARRISH says (p. 132) "the most serious corrosion is *below* the surface of low water beyond the action of the atmosphere, where, at certain points, there seems to be a concentration of the elements favorable to the most rapid deterioration, as is illustrated in pile "C," where a hole 2 ins. deep and 1 in. wide, and another 4 ins. long and 1½ in. wide and deep, occur." On p. 134 he says—"It would then appear from the results of Capt. BROWN'S examination, which is confirmed by my own observation, that the effect of the sea-water on the Brandywine Lighthouse is more serious *below* the surface of the water, where there is a constant, and uninterrupted chemical action in progress, than takes place either between wind and water or in the air, although the total amount destroyed may be greater in the latter case than in the former."

The italics above are ours, showing our quotation to have been correctly made. In the body of the paper Mr. PARRISH implies a distinction between loss of section by oxidation, which attacks the exterior surface to a comparatively uniform depth, and deep pits and seams chargeable to constant chemical action in the water combined with original impurities in the iron. Mr. PARRISH distinctly says that the tops of piles extending a few feet above high water, though probably wet a part of every day, are only covered on the surface with rust, and show no appreciable diminution of diameter or seaming.

Mr. J. F. FLAGG, M. Am. Soc. C. E., in connection with this subject of corrosion in wrought-iron piles, refers our readers to some valuable experiments made by WM. PARKER, Chief Engineer and Surveyor of Lloyd's Register, London, and to be found in *Van Nostrand's Magazine*, vol. 34, p. 193, 1886. These experiments were made on several makes of common wrought-iron, best quality of the same and mild steel. The samples were exposed on a London house-top for 455 days; under sea-water at the Brighton Pier for 437 days; in the bilge-water of a ship trading to the East for 240 days, and in the boilers of three different vessels, one a collier and the others in the East India and China trade, for periods ranging from 264 to 361 days. The loss in decimals of a pound per each square foot of surface is given in each case. In the samples a part of the surface was milled bright, with the remainder milled on the edge only. Of the samples with bright surfaces, those in the boilers of the collier suffered most severely, and those exposed to bilge-water came next. The losses of those exposed to London atmosphere were almost as severe as those exposed for nearly the same time in sea-water; in fact, the steel specimens generally lost the most in the atmosphere. The average loss in sea-water for the milled surfaces was as follows:—

Common Wrought-iron	"	"	0.163	lbs.	per	sq.	ft of surface.
Best	"	"	0.195	"	"	"	"
Mild Steel	"	"	0.207	"	"	"	"

ED. ENG. NEWS.]

A Case in Point as to Bridge Floors and Pin-Connected Trusses.

ALBANY, N. Y., March 4, 1888.

EDITOR ENGINEERING NEWS:

The accident at the Apple River bridge on the Chicago, St. Paul & Kansas City Railway on the 15th ult., illustrates the futility of relying for safety upon guard timbers and strong floors while the bridge trusses themselves are incapable of withstanding the shock of a derailed car.

Here was a bridge of 180 ft. span, finished only a few days before, proportioned in accordance with modern specifications and one that would be accepted by ninety-nine out of a hundred railroads as a thoroughly first-class structure. It had a strong floor of closely spaced ties, with wooden guard timbers flaring at the abutments to catch and guide derailed cars. The ties were further secured in place by spacing ribbons outside of the guard timbers. It does not appear that wooden posts had been planted in line with the trusses to protect the end posts, but in this case they would have done no good, since neither end post showed signs of having been hit. A freight train ran on the bridge with one car off the track. The derailed car rode the ties all right for two or three panel lengths and then "slewed" around, striking the trusses on both sides with the usual result.

This accident recalls a very similar one on a road in Pennsylvania about a year ago. A freight train with a derailed car ran on a bridge of about 120 ft. span, and when partly across, the car, which was riding the ties, turned sideways just as in the Apple River case, and the rest of the train piled up against it. Besides a broken floor-beam and stringers both trusses were injured by the breaking of a tension member in each, the two broken members being directly opposite each other and supporting opposite ends of the same floor-beam.

The difference between the two cases lies just here: that while the Illinois bridge went down and dropped the train into the hole, the Pennsylvania one (though of shorter span and much lighter construction) withstood the shock, and after the wreck was cleared away, was shored up and traffic resumed with little delay until it was convenient to replace the broken parts.

The one was a pin-connected truss, the other a riveted lattice. The moral is obvious.

CHAS. F. STOWELL.

[A still more conspicuous moral in each case, because a more immediate one, is that a re-railing guard would presumably have put both derailed cars back *on* the track, since the slewing was done on the bridge. Both incidents certainly go to controvert the position taken by Mr. DARLEY of the Michigan Central Railroad, in our issue of Jan. 28, which we felt bound at the time to object to as unsound, and which was thus stated:

"If the truth of railroad men's experience could be known, the bulk of evidence, I think, would be in favor of letting a truck take its course across a bridge, instead of trying to turn it, or disturb it at the very point where it is most dangerous to do so. What hurt can it do? It cannot force the car to one side far enough to strike the side of the bridge, nor can the truck itself get foul of any part of the bridge; therefore, as I have said, let it alone, and it will pass the bridge all right."

In both of these cases the truck took its course and went all right half way across the bridge, and then came to grief.—ED. ENG. NEWS.]

A CANADIAN by the name of BARRY has invented an ingenious device for extinguishing car lamps in case of accident, which has recently been tested on the Boston & Lowell Railroad, and would seem to be simple enough to be worth adoption. A small reservoir under the car is charged once for all with compressed air from the brake pipes. Air can enter it at any time to keep up the pressure, but it can only escape through a valve operated by sliding weights, which are only caused to act by a violent collision or considerable tipping of the car. If they do act, the compressed air rushes through tubes to the top of every lamp chimney, and of course blows out the lamp.

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D. McN. STAUFFER. A. M. WELLINGTON.
EDITORS.

GEO. H. FROST, - - - BUSINESS MANAGER.

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Drawings for publication *should preferably be in plain black and white, considerably larger than they are expected to appear, with letters and figures in pencil only, all lines clean and bold.*

Coming Technical Meetings.

Engineers' Club of Philadelphia, Pa.—Regular meeting, March 17. Secy., Howard Murphy, 1122 Girard St.

Boston Society of Civil Engineers, Boston, Mass.—Annual meeting, March 21, at Young's Hotel, 4 P. M. Dinner at 6 P. M. Secy., S. E. Tinkham, City Hall.

Engineers' Club of St. Louis, Mo.—Regular meeting, March 21, "St. Louis Water Supply" W. B. Potter. Secy., W. H. Bryan, 709 Market St.

American Society of Civil Engineers, New York.—Regular meeting, March 21. Secy., John Bogart, 127 E. 23d St.

Civil Engineers' Club of Cleveland, O.—Regular meeting, March 27; Scientific Pursuits. Secy., C.O. Arey, 31 Blackstone Building.

Engineers' Club of Kansas City, Mo.—Regular meeting, April Secy., Kenneth Allen, 19 Deardorff Building.

Association of North American Railroad Superintendents.—Next meeting in New York, April 9.

American Water-Works Association.—Annual meeting at Cleveland, O., April 17, 18, 19. Secy. J. H. Decker, Hannibal, Mo.

American Society of Mechanical Engineers.—Meeting at Nashville, Tenn., in April or May. Secy., F. R. Hutton, 280 Broadway, New York City.

Master Car Builders' Association.—Next convention at Alexandria Bay, N. Y; commencing June 12. Secy., M. N. Forney, 45 Broadway, New York City.

American Railway Master Mechanics' Association.—Next meeting at the Thousand Islands, N. Y.; June 19. Secy., Angus Sinclair, Chicago.

Roadmasters' Association of America.—Next meeting at Washington, D. C. Sept. 11. Secy., H. W. Reed Waycross, Ga.

THE mills of the gods grind slowly, and so does the mill of the Brooklyn Bridge trustees; but they are credibly reported to grind exceedingly fine, and it would ill become this journal, at least, to question that the mill of the Bridge trustees has done so likewise, since the final result of the study which they have caused to be made of the questions raised in our issue of June 4 and June 11, 1887, is to confirm exactly and completely every essential conclusion which we reached, both as to what can and should be done and as to what cannot and should not be done; as will be seen from the Report of the Board of Experts which appears in another column, with the first half of the report descriptive of the recommended plan.

That it should have taken so long a time, more than nine months, to reach so evident a conclusion, nearly six months of which was spent in beginning to get ready to have the facts considered on which to base a conclusion, is a singular commentary on the cumbrousness of some public machinery, but after the Board of Experts was once effectually organized, which was not till Nov. 12, progress has been as rapid as could be expected, considering that the regular duties of the Board would not permit of holding meetings more than once a week; for in reporting on a matter of such importance, even if a general conclusion is early reached, considerable time is necessary to make sure that no important points have been overlooked, and to determine on the exact form and wording of the report.

That the conclusion was in fact an "evident" one, as we originally stated, is clearly indicated by the very emphatic and unqualified manner in which the Board of Experts, which is made up of conservative and well known men, has found itself compelled to speak of each half of the question originally under discussion. Of the system which we took two or three pages to show in detail was not safe the Board of Experts take five lines only to say:

"As this system cannot possibly be operated without the employment of a complicated system of switches, frogs, crossings and signalling apparatus, of more than doubtful efficiency, we are satisfied that it contains elements of danger, of a gravity sufficient to preclude its consideration."

On the other hand, of the system which we then stated was vastly better than any other, the Board of Experts say:

"Of all the plans submitted to our review, the one alone which seems best to conform to the necessary conditions, is the simple "Circulating System," in which the objectionable features of all the others above referred to are eliminated. We have very carefully studied its adaptability to all conditions of the bridge railway traffic, with the result of a decided and unanimous conclusion in our minds that the simple circulating system is unquestionably the one which best and most completely fits the conditions presented; and while deeming it not properly within the scope of this report to enter into extended details of the line of investigatio and of the arguments which have led to this conclusion, doubtless it is proper that we should herein note some of the leading advantages which this system is found to possess, and which have had great weight with us in deciding upon it as the one to be recommended to you."

The Board then enumerate nine such advantages, safety, simplicity, economy, convenience, and what not, no one of which, we may add, gave us more satisfaction to see cogently and forcibly put than the following:

"*Eighth.*—It presents a ground plan of symmetrical shape and proportions, singularly well adapted for a superstructure of dignified beauty, and susceptible of a grandeur of architectural treatment in harmony with the majestic proportion of the great bridge structure, to which it should form a fitting climax, worthy of the two great cities it links together."

The importance of this end, even from a purely utilitarian point of view, has been too long ignored.

In respect to the horrible overcrowding of cars which now prevails on all kinds of street and elevated cars in New York, but nowhere to such aggravated extent as on the Brooklyn bridge, the Board also make some emphatic comments which we cannot but hope will bear fruit. They say:

"We beg leave to draw your attention to an aspect of the case which has not apparently thus far reeceived the attention it deserves, and to respectfully suggest that the management of this great Bridge should assume the initiative in a manifestly much needed reform in our system of street car traffic generally. Yours being the only line of public travel, the management of which is wholly in the control of public authority, an example to others set by you, adding so materially to the comfort and safety of the travelling public, could not fail to secure its highest commendation; we refer to a reform in the existing barbarous custom of allowing standing passengers to crowd the cars to more than double their seating capacity, sometimes carrying over one hundred in a car seating but forty. Under these circumstances, the slightest panic or apprehension of danger becomes at once seriously magnified, subjecting the weak, timid and helpless to a degree of nervous suffering certainly not in accord with modern civilization, nor with a just regard to the rights and privileges of others. To remedy this, and give every passenger a seat would, by 1897, with the assumed minimum of traffic, require the ability to circulate over six times as many cars in a single hour as is done on the present system of three-car trains, forty trains per hour, and over four and one-half times as many as will be moved under the four-car train system soon to be inaugurated."

This capacity and much more is provided in the recommended plans, and provided in so economical a manner, as is in part shown elsewhere, that the operating expenses need not be increased more than ten per cent. to handle nearly four times as many cars per hour (468 instead of 120), *without considering* the saving by completely doing away with switching and switching engines, by which alone enough is saved to more than cover the interest on the probable first cost of the improvements complete, including the two large terminal buildings. This being so, the chances seem good that it will not be long before the "Brooklyn bridge problem" will be a thing of the past, although "doubtful things are mighty onsartin," especially in municipal politics.

The Board of Experts give no further details as to the 17 plans and modifications of plans, submitted to them, except that they all belong to one or the other of the following general methods of operation:

I. The present "Tail Switching" System.
II. The "Head House" System.
IV. The "Loop" System.
III. The "Circulating" System.

The last system was represented by only one plan, that recommended. The first two systems alone had been suggested when we first discussed the question in June last, and then declared the "continuous circulation type, over an endless track" to be greatly preferable to either, giving at that time a rude cut of what has since become known as the "circulating system," which we wonder did not give the hint to some one of the other features of that type besides the endless circuit. This did not happen, however, although six or eight plans embodying the latter feature, but otherwise differing radically from the "circulating" type, have been since brought forward, and are collectively termed the "loop" type.

It will be noticed that the report of the Board of Experts condemns the "tail switching," "head-house" and "loop" types *as types*, and not because of defects in the individual plans, which are not even mentioned; and this brings up a fact which it appears to us should in justice be mentioned. These three rejected types include all the methods of handling trains at termini now anywhere in use. They were invented to suit the needs of a far lighter traffic, and answer admirably for heavy traffic *up to a certain point.* But that point is already reached and passed, and it does not lie within the wit of man to stretch them still further without entirely inadmissible sacrifices of both safety and public convenience.

It is to be remembered that crowded traffic in the modern sense is a very recent thing; even five years ago it existed nowhere in the world. The Brooklyn bridge cable tracks are already the most crowded bit of railway in the world. No other pair of tracks anywhere is carrying anything like the same traffic *between single terminals*, although the Third Avenue elevated is carrying more with two or three terminals at each end. *A new system* was necessary for these new needs; one which would enable enormous trains to load and unload in a few seconds, in a very small area, with the simplest possible operating routine and with no frogs and switches, and with trains following almost immediately upon each other. For ordinary traffic these advantages are superfluous. For extraordinary traffic they are indispensible.

PROBABLY one of the thoughts which most frequently recurred to property holders and insurance men in this city during the recent great storm was the great danger in which the city lay from the outbreak of fires. About 50 per cent of the alarm boxes were useless on account of the fallen wires; the severity of the storm was such as to make it impossible for firemen to work with their usual efficiency; the cold was so intense that all forms of heating apparatus were pushed to their full capacity, greatly increasing the liability to fire outbreaks; and many streets were so deeply filled with snow that it was impossible to drag the heavy engines and trucks through them. Fortunately no very serious outbreaks occurred. At a fire in Laight street, two alarms were rung in and of the seven engines which were due, but four finally reached the fire and three of these only after long delay. The other three engines and two hook and ladder trucks were stalled in the snowdrifts and had to be abandoned. The four companies in service succeeded in confining the fire to the building in which it started. The fire department authorities were well aware of the great responsibility which lay upon them, and did all in their power to secure safety. With the cooperation of the police force a sort of fire patrol was kept up and the Fire Insurance Patrol Committee organized a special guard for watching the dry goods district which obviated to some extent the danger from the broken wires.

BUT the fact that many New York streets have been, during the greater part of this week, so blocked with snow as to be absolutely impassable to the trucks and engines of the Fire Department is certainly cause for grave apprehension. It is true that such a complete blockade is the occurrence of a century, but it is also true that in the average winter there is generally some time when for a period of a week or more the fire department is considerably hindered in answering alarms by the depth of snow, especially in the less thickly settled districts in the upper part of the city. It would seem that this might be easily avoided at an expense small enough to render the plan feasible, by some simple device for putting the engines and trucks upon runners whenever the sleighing in the district they protect is better than the wheeling. A piece of channel iron of the width of the wheel tire bent up at the end to fit the front wheel, with a few bolts and braces to hold it in place, would answer every purpose and by setting and fastening the wheels into it, an operation which need not take five minutes, the engine truck would be transformed into a sleigh which could be drawn over the snow much more easily, safely and swiftly than the fire engines are generally drawn over New York pavements. What is applicable to New York is of course still more applicable to cities subject to greater snow falls which still keep their fire engines on wheels through the winter.

WHEN one walks through some of the narrow streets in the office section and dry goods district of down town New York and sees the snow piled four or five feet deep over the whole width of the street; when he realizes the number of million dollars' worth of property which are wholly at the mercy of an outbreak of fire, and when he thinks of the possible occurrence of a conflagration, which, once beyond control of the fire department, nothing but want of fuel could stop, he is ready to agree that any possible additional effectiveness in our fire department should certainly be secured.

ANOTHER lesson from the storm which will probably prove decisive is that tracks sunken in an open trench, such as Mayor HEWITT proposed for the proposed Elm Street rapid transit line, are the most difficult of all to keep in working order in a snow storm. The elevated lines did nobly in the storm. They were interrupted during some 36 hours while it continued, indeed, for the first time in their history, but as soon as it stopped began operating almost immediately. Tracks laid in an an open trench would be sure to be blocked several times each winter, because even a moderate storm will half fill them if there be any wind. Because of this feature in the New York Central tracks they were the last entering the city to be made passable, yet their conditions are not nearly so bad as would obtain in an open trench some miles long, because that form of roadbed exists only on short sections. On the other hand an underground road would not be likely to be interrupted at all by any storm whatever.

WE happened to see about a week ago a paragraph stating that there was a certain competition going on in the Signal Service office between a certain army officer and a certain civilian, with a view of determining not only their individual competency, but which *class* of men was likely to prove most efficient for that duty. We remember thinking at the time that the suggested method was a rather absurd one, but in view of the late storm, we think the Chief Signal Officer might select the class which was *not* on duty when it began "and make no mistake," for the office has never made a more ridiculous fiasco, nor one for which it is more difficult to imagine any excuse. The storm was almost continental in extent; it was phenomenally violent, phenomenally unseasonable, phenomenally prolonged, and a phenomenal combination of heavy wind and heavy snow. There must have been signs of such an event somewhere, for at least 24 hours ahead, which even the wayfaring man need not mistake if he knew anything at all about meteorology, yet almost at the instant the storm was beginning, came the prediction, "clearing colder weather, preceded by light snow."

The peril of the city from fire, from the combined causes of broken telegraphic circuits, impassable streets, and fierce winds, certainly should lead to the burying of the police and fire wires underground if none others are placed there. Had a fire in one large inflammable building gained a good start it could hardly have failed to ignite a block, and with one large block on fire, the Chicago catastrophe might well have been far outdone. Because the result did not happen, the usual tendency is to ignore the danger as well, but as thousands of people must have been impressed with it, we trust it will not prove so in this case. The fire wires at least, should be beyond the reach of storms in a city like New York.

THE immense difference in the practical working loads of American and European locomotives is illustrated by a table contained in a paper on the "most economical speed for freight trains, together with the effect upon the running cost of the speed, the varying grades and curves of the track and the weight of the traffic, by Prof. ALBERT FRANK, of the Technological School at Hanover," from whom we recently published a letter on this subject. The table is primarily for the purpose of illustrating the effect of speed on tractive capacity but it sheds all the more light on the comparative work done by German and American locomotives, because it was not intended for any such purpose. We add for comparison the working loads for an American Consolidation engine with 40 tons of 2,000 lbs., as compared with the load hauled by a German engine with 38½ tons of 2,204 lbs.

Gross Weight of Train in tons of 2,204 lbs. which can be hauled by an Engine having 38.5 tons on drivers, = 42¾ short tons at various velocities.

Grade per cent	Miles per Hour.					American Light Consol'n
	10	11	12	15	17½	
level	1941	1782	1432	1183	996	2430
0·20	1066	977	786	651	547	1597
0·33	814	742	597	493	414	1300
0·50	619	565	453	372	312	1041
1·00	348	317	250	201	165	644

The Consolidation engine has 40 tons of 2,000 lbs. on drivers and the loads given are also tons of 2,000 lbs.

The contrast is certainly most instructive, not only in the absolute loads but in the comparative effect of grades, which is much less with American engines because of the higher rate of adhesion they work up to. The enormous alleged decrease of hauling capacity, from slight increments of speed, which is shown above, corresponds to nothing in American practice, nor, we believe in German, but it is made the basis of quite elaborate calculations. That it should be so, well illustrates the German peculiarity of being intensely theoretical.

A fine example of "English as she is wrote" in foreign technical journals by gentlemen who wish to interest English-speaking people —and succeed in doing so—has been sent us by a subscriber, who cut it a year or so ago from a German technical paper. It is surrounded in the original with some filagree typographical work which we cannot attempt to imitate from the resources of our printing office, but the business part of it is *verbatim et literatim* as follows:

One surches succour

for realizing a new invention in carting, which inables to cart by only pression, in the manner, that one can move, by any means of any load of the lever, a load, at least 3 or 4 times heavier and larger on every street, like if it was drown by horses. The manner of moving is simple, quite natural, imitating that of living beings. In order to erect a greater specimen of this machinery, and to get a foreign patent-protection, 2000 francs are wanted.

He who will give a succour to these expenses, is to receive an according provision and to get back his money within an year's time. 5050

The inventors adress can be had at the expedition of the „Vaterland", where also a testimony may be seen.

We trust our friend found his succour, but he was surching it in the wrong place. He should have come to ENGINEERING NEWS, where at last he gets a very conspicuous advertisement free, but too late, we fear, to do him any good.

The Metropolitan Development of New York.

The large inset map which accompanies this issue, showing the "Relative Residence Areas of New York and Brooklyn in Equidistant Belts from the NEW YORK City Hall" tells a story which has attracted singularly little attention—perhaps one might more truly say, no attention—from the people of New York and Brooklyn, considering how vitally important it is to the future of those cities, viz.; how absolutely indispensable it is to the future of this metropolis as a whole that the East River should be practically eliminated as an impediment to internal transit between New York and Brooklyn.

IT is, in our judgment, the most important feature of the plans for the improvement of the Brooklyn bridge transit facilities which have been recently recommended by the Board of Experts that they for the first time bring forward an easy and inexpensive way of

doing this. Their report, and the first part of the report submitted to them descriptive of the recommended plan, appears elsewhere in this issue; but we are not concerned with the details of that particular plan; still less have we any purpose or intent to enlarge upon its merits or demerits, to do which would be inappropriate to these columns. All we aim to do, which is quite enough for one article, is to bring out as clearly as possible the general nature of the problem of municipal development for New York, and the importance to both New York and Brooklyn of fixing on *some* plan, *any* plan, for eliminating the East river as an impeding factor to the symmetrical growth of the metropolis as a whole.

We need hardly say that the natural mode of growth of large cities, when not interfered with by topographical causes, is by a circular spreading of population in all directions, the residence area under these conditions increasing as the *square* of the distance from the center. London, Paris, Philadelphia, Boston (to some extent) and various other great cities, are examples of this law, under which the available residence area increases so rapidly that no serious congestion of population is possible, with its attendant evils of high rents, heavy expenses and wretched living. It has been possible to some extent in the past, because of the lack of quick and cheap internal steam transportation, which is a very modern thing, but it is no longer possible in such cities on a considerable scale, and it is a well known fact that so much of it as has come down as a heritage of the past is rapidly diminishing under the stimulus of improved methods of internal transportation, where they exist.

A still larger class of cities, of which Chicago, Brooklyn and Liverpool may be taken as types, are restricted topographically to a fan-like or semicircular process of development, instead of to a circular. In fact, as every great city in the world is situated either on a river or large body of water, this fan-like process of development may be said to be characteristic of all great cities, except, perhaps, London and Paris, since even a small river, like the Delaware at Philadelphia, suffices to greatly impede the complete circular development.

But even where, as at Chicago or at Brooklyn, the area open for growth is strictly semicircular, so that the development of the city must be purely fan-like, the same general law holds that the available residence area increases as the *square* of the distance, nor does the loss of the other half of the circle make so much difference in the convenient growth of the city as might be supposed. The residence area *within a given distance*, indeed, is only half as great, but as it requires a comparatively small distance further to double the available area *the necessary distance to include an equal area* is only 41 per cent. greater (1 to $\sqrt{2}$) in a "semi-circular" city than in a "circular" one, so that they compare as follows:

Comparative Radial Distances to include Equal Areas.

In "circular" cities like London.	In "semi-circular" cities like Chicago or Brooklyn.	Area in sq. miles included by the given radius, in each case.
miles	*miles*	
2	2.83	12.57
3	4.24	28.27
4	5.66	50.27
5	7.07	78.54
6	8.49	113.10
7	9.90	153.94
8	11.31	201.06
9	12.73	254.47
10	14.14	314.16

In each case the distance given for the "semi-circular" city is 41.4 per cent. greater only than for the complete circular development, which is not a particularly burdensome addition. Even in case a city be so situated as to be able to grow over one quadrant only (90°) of a complete circle, the distances only need to be twice as great to include equal areas, and a city which can expand over an area covering three-quarters of a complete circle (270°) only needs to extend 15½ per cent. farther to include an equal area. In other words, to include an area of 50 sq. miles:

	miles
A "circular" city like London or Paris, growing freely in all directions, extends outward from its center for a distance of	4
A city having only three quadrants of a complete circle to expand in, will extend outward a distance of	4.62
A "semi-circular" city, like Chicago or Brooklyn, having only two quadrants of a circle to expand in, will extend outward from the center for	5.66
A city having only one quadrant of a circle to expand in, the other three quadrants being occupied by water or otherwise uninhabitable or inaccessible, will extend outward from its center (*i. e., apex*) for	8

We recall no city of much size which has only one quadrant of a circle to grow in, but there are a number which have practically about three quadrants available, and it will be seen that in neither of the first three cases is the difference of distance to include the same area a very serious matter, while even in the last class, as the business center of a "single quadrant" city would not be at the very apex of the quadrant but a mile or so back of it, the radial distance above to include the same residence area would really be only 6 or 7 miles, instead of 8 miles. So that the comparison with even an unrestricted circular development is not so very unfavorable, even in this extreme case.

But New York is peculiar among the great cities of the whole world (and even among the second and third rate cities), in that its development is purely linear. Instead of the available area increasing as the *square* of the distance from the center, or even increasing directly as the distance, the increment of area rather grows less as the distance increases. The map of Manhattan island resembles nothing so much as the head of a gigantic seaserpent, or perhaps tadpole, of which the City Hall Park is the eye and the head the widest part. If the area of Central Park be conceived to be taken out of the coast line instead of the center of the island the resemblance is still more striking. Even including the fragment of the "Annexed District" (Morrisania) shown on our map, the total available area within given distances from the business center of the city makes the following very unfavorable comparisons with "circular" cities like London or "semi-circular" cities like Chicago:

Available Residence Area, sq. miles.

Within a radius from the center of	London	Chicago	New York	N. Y. and Bk'n together.
1 mile	3.14	1.57	1.8	1.8
3 miles	12.57	6.28	4.1	5.0
3 "	28.27	14.13	6.1	9.7
4 "	50.27	25.13	8.0	16.6
5 "	78.54	39.27	9.5	26.1
6 "	113.10	56.55	10.9	40.1
7 "	153.94	76.97	12.5	56.9
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[*The Brooklyn area includes only so much of each belt as is shown on the map herewith.* There is really a good deal more available area in the 8th and 9th mile belt than is shown on the map, although a part of each, outside the limits of the map, is lost by arms of the sea and marshes.]

Under these conditions very grave evils, which have been and will continue to be serious impediments to the growth of the city, have arisen in New York. The magnificent harbor and water ways which have made it the great city that it is have not been wholly unmixed blessings, since they have forbidden a natural mode of growth. Rents and land values are very high; living expenses are high; in the sections inhabited by the poor, who must constitute the vast majority of every great city, a terrific congestion of population has resulted, far greater than exists on a large scale in any other civilized city. Despite the fact that all kinds and grades of wage-earners earn more and spend more (because they must to live) than suffices for a certain decent luxury in Philadelphia or London, their homes in New York are poor and squalid to a degree. London has grown up under different and much less favorable social conditions than New York, so that there is vastly more misery there than there would be under American conditions, but the contrast in the condition of the poor in New York and Philadelphia is a painful one indeed. Wages are decidedly lower in Philadelphia, but almost every working man has a home and a roof of his own, whereas in New York few heads of a family can afford it on incomes of less than $3,000 or $4,000 a year. As a consequence, the whole eastern third of the city, beyond the Bowery and Third Avenue, a few oases excepted, is one vast and squalid tenement region, crowded to suffocation with human beings, and a breeding place of wretchedness and crime.

The western two-thirds of the city has spots of the same character, but in the main it is given up to the homes of the well-to-do. Even here, however, the same relative conditions obtain; rents are extremely high; those wretched substitutes for homes known as "boarding-houses" and "flats" abound more than anywhere else on the civilized globe; all provisions and supplies are dear, both because of the rents and cost of living, and because of the distance they must be carted. As a consequence tens of thousands of families are spending $3,000 to $8,000 a year to maintain more or less "style" in three or four rooms, who could even in Boston or Philadelphia, and still more in smaller cities, live in handsome and roomy homes for much less money.

Nevertheless, in spite of the fact that in every commercial or manufacturing establishment every one from the manager to the office boy must earn more and live worse than he would anywhere else for the money, New York grows rapidly, but its growth will never be *as* fast nor *as* great as if these disadvantages were remedied without sacrifice of its unique and unequalled advantages as a commercial metropolis, which have made it what it is. The one way to do this is TO EXTEND THE RESIDENCE AREA, which can only be done effectually by the practical elimination of the East river as an obstacle to quick and cheap transit. The map which we publish, and which the Board of Experts for the New York and Brooklyn bridge have attached to their report, makes this too clear for doubt. In fact Brooklyn has for thirty years been the relief-valve for New York against conditions which would have otherwise have long since become intolerable. A city of 836,000 people has grown up there, against perhaps 1,450,000 in New York proper, or some 2,500,000, including Jersey City and other metropolitan suburbs, making New York already the second city of the world.

But New York is plainly destined to be not the second but the first city of the world. If the 30,000,000 of people on the little island of Great Britain can support a metropolis of 4,000,000 it needs no demonstration that not 5,000,000 nor 8,000,000 nor possibly even 10,000,000 will be the ultimate limit to the population of New York. Where are the people to go to, except to Brooklyn?

Across the Hudson river, on the west, there is practically no available room until the other side of the Jersey flats are reached, some six miles off. The area nearer New York is given up to salt marshes, mosquitoes, enormous railway terminals and the Palisades. A bridge over the Hudson river may result in the building up of a great city at Newark and Orange, but at much disadvantage.

To the north, beyond the limits of our map, the area broadens out somewhat, but not very

much until we get 15 or 16 miles from the City Hall, in other words, beyond the reasonable limits of city growth. The little sketch of this region below shows this clearly. There will be in time another great city, north of the Harlem river, but it will grow up under

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the great disadvantage of a 10 or 12-mile ride to the business center of the metropolis; for there can be no reasonable doubt that this will for a century to come (see diagram in ENGINEERING NEWS, Feb. 18, 1888), be within the area colored dark on the map.

In the meantime the population of the metropolis as a whole is increasing *in an* INCREASING *geometrical ratio* (see investigation of Mr. RUDOLPH HERING in ENGINEERING NEWS of Jan. 15, 1887,) and the island itself needs only a few years more to crowd it to repletion.

On the other hand, there is still room to add a million of new homes at reasonable rates within reasonable distance of the business center in the great Brooklyn area shown on our map, which looks as if it had been planned by nature to be the residence area for the New York business section. Nearly all of it has a dry and sandy soil, and is high and easily drained, while a large part of it is pre-eminently attractive for residence, except for its one great drawback, comparative inaccessibility. In all, within a distance of 9½ miles from the New York City Hall there is about 7½ times the available residence area that there is on Manhattan island as shown in the following table:

Ratio of the Area of Each Residence Belt in Brooklyn to the Area of the Corresponding Belt in New York.

[In this table the arcs marked 3 Miles, 4 Miles, etc. are assumed to pass through *the center* of each belt. All park areas excluded.]

Belt	Area in Sq. Miles N. Y.	Area in Sq. Miles B'kl'n.	Ratio N. Y. to B'kl'n.
3 M	1.9	4.3	1 to 2.24
4 M	1.6	5.8	1 " 3.62
5 M	1.5	11.0	1 " 7.33
6 M	1.3	13.7	1 " 10.54
7 M	1.7	15.6	1 " 9.18
8 M	0.9	13.2	1 " 5 00
Total	8.9	63.6	1 " 7.15

The great city which now occupies a fifth or a sixth of this area has grown up under great disadvantages, except as respects the little fraction of it within walking distance of the ferries. To reach the rest of it, a man has had to walk to the ferries, risk frequent delays thereon, scramble for a seat in the horse-car, take a long and slow ride therein, and perhaps change to still another vehicle to reach the point from which he finally walks to his home. Thus he has consumed from 60 to 80 minutes in reaching points in the 4 mile to 7 mile belts, which are reached on Manhattan island in 20 to 30 minutes by a continuous and comfortable trip. It is almost as long a trip, and a much more uncomfortable one, to reach up-town New York from this region than it is from Philadelphia, 90 miles off.

The inevitable tendency has been to make Brooklyn a second class town. Rents are vastly cheaper there than in New York; a fixed income will go much further there, but as a rule, with of course many exceptions, only those who feel obliged to make their income go as far as possible have been willing to put up with the discomforts of living there, in comparative exile. This fact is so notorious that it is needless to enlarge on it further: The consequence of these conditions is visible in the following table:

Comparative Areas, Assessed Valuation, and Assessed Valuation per Square Mile of the Belts at Equal Distances from the NEW YORK City Hall in the Cities of New York and Brooklyn, as Shown in the Accompanying Map.

Belt from City Hall.	NEW YORK. Area sq. miles.	NEW YORK. Assessed Value in millions.	NEW YORK. Assessed Value per sq. mile.	BROOKLYN. Area sq. miles.	BROOKLYN. Assessed Value in millions.	BROOKLYN. Assessed Value per sq. mile.
Below City Hall.	0.5	159.4	$318,800,000	—		
C. H. to 1 M.	1.3	170.1	130,800,000	—		
1 to 2 M.	2.3	213.9	93,000,000	0.9	66.3	$73,700,000
Total business section.	4.1	543.4	$132,500,000	0.9	66.3	$73,700,000
2 to 3 M.	2.0	194.8	$97,400,000	2.7	88.0	$32,600,000
3 to 4 M.	1.9	186.8	98,300,000	5.0	114.9	23,000,000
4 to 5 M.	1.5	106.7	71,100,000	8.0	66.7	8,300,000
5 to 6 M.	1.4	79.1	56 500,000	12.6	36.2	2,900,000
6 to 7 M.	1.6	47.5	29,700,000	15.2	19.2	1,900,000
7 to 8 M.	1.9	47.4	25,000,000	10.5	7.0	400,000
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Total residence section.	13.3	699.1	$52,600,000	61.2	335.0	$5,470,000

NOTE.—Brooklyn is considered for the purposes of this table to include the *entire* area of Long Island, as shown in the map, and nothing beyond the limits of the map. The assessed valuation (1887) of this whole area is, as nearly as may be, $401,300,000.

The area of both New York and Brooklyn which lies within a distance of 2 miles of the New York City Hall is regarded as the business section, and colored dark olive. In reality the area thus colored in Brooklyn is for the most part a choice residence section, its value per square mile being about that of New York residence property above 59th Street.

The assessed valuation in both New York and Brooklyn is supposed to be somewhat less than 60 per cent. of the market value.

The areas given exclude all park areas. No attempt has been made to make the areas precise. They have been simply scaled from the map.

The valuation of each ward, in millions of dollars and fractions, is shown in red. The fraction of this valuation appertaining to each mile belt has been estimated, as also the valuations of the outlying towns, which are not given on the map.

Now if we may suppose an intelligent inhabitant of the moon to be suddenly landed in this metropolis, to be told that it was inhabited by one of the wealthiest, most enlightened and most progressive people in the world, to be shown the map which we publish in this issue, and to be told that in the effort to eliminate the East river this people had constructed the greatest and most costly bridge in the world to connect New York and Brooklyn, a bridge capable of carrying over a million people daily, so far as the structure itself is concerned; and if he were told, furthermore, that on the little area of Manhattan Island fully 200,000,000 people yearly were carried back and forth in elevated trains, and as many more by horse-cars, and that of this total fully 150,000,000 elevated passengers and 50,000,000 horse-car passengers were carried to and from their homes to the *down-town* business section only; and if he were then asked what this people had done to facilitate communication with the Brooklyn area, *via* the bridge.—what would be his probable response?

Surely it would be that the Brooklyn people for their own convenience, and the Brooklyn property owners for their own profit, must have united in an effort to exhaust the resources of engineering to place Brooklyn strictly on an equality with New York as respects transit conveniences, so that the resident on any one of the colored Brooklyn belts would be able to reach his New York office as quickly and as conveniently as from the belt of like color in New York, at a like distance from the business center. He might probably surmise, as is the fact, that 45,000,000 or 50,000,000 people per annum, living convenient to the river front would patronize ferries from Brooklyn, just as a nearly equal number uses the horse-cars in New York, but balancing one of these against the other, and neglecting both, he would surely conclude that if 150,000,000 people per annum were passing to and from the up-town residence area and the *down-town* business section, at least as many were coming from the Brooklyn area seven times greater, and perhaps two or three times as many. After computing that if equal areas at equal distances were contributing equal traffic there would be 7½ times as many passengers from Brooklyn as from upper New York, or 1,087,500,000 passengers per annum, he would probably estimate that there were in fact 300,000,000 or 400,000,000.

If told that, instead of any of these numbers, there were only 30,000,000 passengers per annum coming to New York from this great area, and that these used the bridge only under conditions of great discomfort, viz., over crowded cars, transhipment at the bridge terminus, and slim chance of getting a seat afterwards, what would be his further conclusion?

Surely that the boasted enterprise and foresight of this people had been somewhat overpraised; and such we think must be the conclusion of any one, should the present state of things continue much longer, for hereafter at least there can be no excuse for it. Heretofore there has been no definite plan for doing anything better than is now done, but in the report of the Board of Experts which we publish herewith there is at least one method recommended unequivocally for accomplishing the ends which we have noted at practically no expense, since the cost is met by a saving in annual operating expenses. If there be a better plan, let it by all means be adopted. We are not writing in the interest of that or any particular plan, but simply to point out that the present state of things is an absurdity which should no longer be tolerated. It is plainly within the powers of engineering to connect Brooklyn and New York as completely as if the East river did not exist, and it should be done if it would cost $20,000,000 or $30,000,000 instead of practically nothing, for the simple reason that *it will pay*. The Brooklyn area shown has already an assessed valuation of some $400,000,000. Give it sufficiently excellent transit facilities and who that examines the tabular contrast above can doubt that this valuation can be doubled? But if it were merely increased 10 per cent. by expending

doing this. Their report, and the first part of the report submitted to them descriptive of the recommended plan, appears elsewhere in this issue; but we are not concerned with the details of that particular plan; still less have we any purpose or intent to enlarge upon its merits or demerits, to do which would be inappropriate to these columns. All we aim to do, which is quite enough for one article, is to bring out as clearly as possible the general nature of the problem of municipal development for New York, and the importance to both New York and Brooklyn of fixing on *some* plan, *any* plan, for eliminating the East river as an impeding factor to the symmetrical growth of the metropolis as a whole.

We need hardly say that the natural mode of growth of large cities, when not interfered with by topographical causes, is by a circular spreading of population in all directions, the residence area under these conditions increasing as the *square* of the distance from the center. London, Paris, Philadelphia, Boston (to some extent) and various other great cities, are examples of this law, under which the available residence area increases so rapidly that no serious congestion of population is possible, with its attendant evils of high rents, heavy expenses and wretched living. It has been possible to some extent in the past, because of the lack of quick and cheap internal steam transportation, which is a very modern thing, but it is no longer possible in such cities on a considerable scale, and it is a well known fact that so much of it as has come down as a heritage of the past is rapidly diminishing under the stimulus of improved methods of internal transportation, where they exist.

A still larger class of cities, of which Chicago, Brooklyn and Liverpool may be taken as types, are restricted topographically to a fan-like or semicircular process of development, instead of to a circular. In fact, as every great city in the world is situated either on a river or large body of water, this fan-like process of development may be said to be characteristic of all great cities, except, perhaps, London and Paris, since even a small river, like the Delaware at Philadelphia, suffices to greatly impede the complete circular development.

But even where, as at Chicago or at Brooklyn, the area open for growth is strictly semicircular, so that the development of the city must be purely fan-like, the same general law holds that the available residence area increases as the *square* of the distance, nor does the loss of the other half of the circle make so much difference in the convenient growth of the city as might be supposed. The residence area *within a given distance*, indeed, is only half as great, but as it requires a comparatively small distance further to double the available area *the necessary distance to include an equal area* is only 41 per cent. greater (1 to $\sqrt{2}$) in a "semi-circular" city than in a "circular" one, so that they compare as follows:

Comparative Radial Distances to include Equal Areas.

In "circular" cities like London.	In "semi-circular" cities like Chicago or Brooklyn.	Area in sq. miles included by the given radius, in each case.
miles	*miles*	
2	2.83	12.57
3	4.24	28.27
4	5.66	50.27
5	7.07	78.54
6	8.49	113.10
7	9.90	153.94
8	11.31	201.06
9	12.73	254.47
10	14.14	314.16

In each case the distance given for the "semi-circular" city is 41.4 per cent. greater only than for the complete circular development, which is not a particularly burdensome addition. Even in case a city be so situated as to be able to grow over one quadrant only (90°) of a complete circle, the distances only need to be twice as great to include equal areas, and a city which can expand over an area covering three-quarters of a complete circle (270°) only needs to extend 15½ per cent. farther to include an equal area. In other words, to include an area of 50 sq. miles:

	miles
A "circular" city like London or Paris, growing freely in all directions, extends outward from its center for a distance of	4
A city having only three quadrants of a complete circle to expand in, will extend outward a distance of	4.62
A "semi-circular" city, like Chicago or Brooklyn, having only two quadrants of a circle to expand in, will extend outward from the center for	5.66
A city having only one quadrant of a circle to expand in, the other three quadrants being occupied by water or otherwise uninhabitable or inaccessible, will extend outward from its center (*i. e., apex*) for	8

We recall no city of much size which has only one quadrant of a circle to grow in, but there are a number which have practically about three quadrants available, and it will be seen that in neither of the first three cases is the difference of distance to include the same area a very serious matter, while even in the last class, as the business center of a "single quadrant" city would not be at the very apex of the quadrant but a mile or so back of it, the radial distance above to include the same residence area would really be only 6 or 7 miles, instead of 8 miles. So that the comparison with even an unrestricted circular development is not so very unfavorable, even in this extreme case.

But New York is peculiar among the great cities of the whole world (and even among the second and third rate cities), in that its development is purely linear. Instead of the available area increasing as the *square* of the distance from the center, or even increasing directly as the distance, the increment of area rather grows less as the distance increases. The map of Manhattan island resembles nothing so much as the head of a gigantic sea-serpent, or perhaps tadpole, of which the City Hall Park is the eye and the head the widest part. If the area of Central Park be conceived to be taken out of the coast line instead of the center of the island the resemblance is still more striking. Even including the fragment of the "Annexed District" (Morrisania) shown on our map, the total available area within given distances from the business center of the city makes the following very unfavorable comparisons with "circular" cities like London or "semi-circular" cities like Chicago:

Available Residence Area, sq. miles.

Within a radius from the center of	London	Chicago	New York	N. Y. and Bk'n together.
1 mile	3.14	1.57	1.8	1.8
3 miles	12.57	6.28	4.1	5.0
3 "	28.27	14.13	6.1	9.7
4 "	50.27	25.13	8.0	16.6
5 "	78.54	39.27	9.5	26.1
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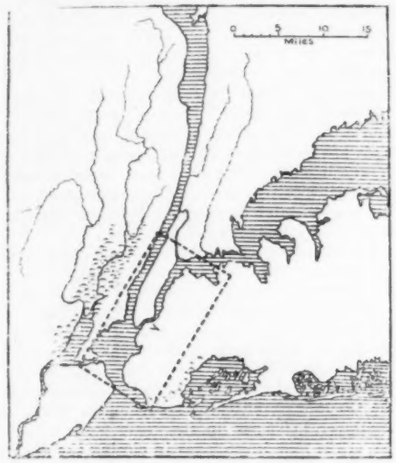

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5 to 6 M.	1.4	79.1	56,500,000	12.6	36.2	2,900,000
6 to 7 M.	1.6	47.5	29,700,000	15.2	19.2	1,200,000
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The areas given exclude all park areas. No attempt has been made to make the areas precise. They have been simply scaled from the map.

The valuation of each ward, in millions of dollars and fractions, is shown in red. The fraction of this valuation appertaining to each mile belt has been estimated, as also the valuations of the outlying towns, which are not given on the map.

Now if we may suppose an intelligent inhabitant of the moon to be suddenly landed in this metropolis, to be told that it was inhabited by one of the wealthiest, most enlightened and most progressive people in the world, to be shown the map which we publish in this issue, and to be told that in the effort to eliminate the East river this people had constructed the greatest and most costly bridge in the world to connect New York and Brooklyn, a bridge capable of carrying over a million people daily, so far as the structure itself is concerned: and if he were told, furthermore, that on the little area of Manhattan Island fully 200,000,000 people yearly were carried back and forth in elevated trains, and as many more by horse-cars, and that of this total fully 150,000,000 elevated passengers and 50,000,000 horse-car passengers were carried to and from their homes to the *down-town* business section only; and if he were then asked what this people had done to facilitate communication with the Brooklyn area, *via* the bridge.—what would be his probable response?

Surely it would be that the Brooklyn people for their own convenience, and the Brooklyn property owners for their own profit, must have united in an effort to exhaust the resources of engineering to place Brooklyn strictly on an equality with New York as respects transit conveniences, so that the resident on any one of the colored Brooklyn belts would be able to reach his New York office as quickly and as conveniently as from the belt of like color in New York, at a like distance from the business center. He might probably surmise, as is the fact, that 45,000,000 or 50,000,000 people per annum, living convenient to the river front would patronize ferries from Brooklyn, just as a nearly equal number uses the horse-cars in New York, but balancing one of these against the other, and neglecting both, he would surely conclude that if 150,000,000 people per annum were passing to and from the up-town residence area and the *down-town* business section, at least as many were coming from the Brooklyn area seven times greater, and perhaps two or three times as many. After computing that if equal areas at equal distances were contributing equal traffic there would be 7¼ times as many passengers from Brooklyn as from upper New York, or 1,087,500,000 passengers per annum, he would probably estimate that there were in fact 300,000,000 or 400,000,000.

If told that, instead of any of these numbers, there were only 30,000,000 passengers per annum coming to New York from this great area, and that these used the bridge only under conditions of great discomfort, viz., over crowded cars, transhipment at the bridge terminus, and slim chance of getting a seat afterwards, what would be his further conclusion?

Surely that the boasted enterprise and foresight of this people had been somewhat overpraised; and such we think must be the conclusion of any one, should the present state of things continue much longer, for hereafter at least there can be no excuse for it. Heretofore there has been no definite plan for doing anything better than is now done, but in the report of the Board of Experts which we publish herewith there is at least one method recommended unequivocally for accomplishing the ends which we have noted at practically no expense, since the cost is met by a saving in annual operating expenses. If there be a better plan, let it by all means be adopted. We are not writing in the interest of that or any particular plan, but simply to point out that the present state of things is an absurdity which should no longer be tolerated. It is plainly within the powers of engineering to connect Brooklyn and New York as completely as if the East river did not exist, and it should be done if it would cost $20,000,000 or $30,000,000 instead of practically nothing, for the simple reason that *it will pay*. The Brooklyn area shown has already an assessed valuation of some $400,000,000. Give it sufficiently excellent transit facilities and who that examines the tabular contrast above can doubt that this valuation can be doubled? But if it were merely increased 10 per cent. by expending

$20,000,000 there would still be 100 per cent. profit on the operation.

Such a result is really as important to New York proper as to Brooklyn. New York values will not fall because Brooklyn values rise, but rather the contrary. The effect of a *complete* elimination of the East river as an obstacle to the growth of the city (which can only be fully attained by two or three bridges in place of one, as the map makes tolerably clear) would in our view be as follows:

New York will for the first time have a *healthy* unimpeded growth. The horribly overcrowded tenement population will gradually melt away, and be transfered to cheaper and better homes at Flushing, Canarsie and Gravesend. Clerks and other people of small income will gain a similar advantage, as would also people of large income, for Brooklyn will cease to repel them. The disproportionate expense of doing business of any kind in New York will consequently disappear, leaving the advantages of doing so unchanged. Hence manufacturing especially will be greatly stimulated, and many other kinds of business which now avoid New York if possible will gradually center here. The end will be that nearly all New York below 42d. St., will be given up to business and manufacturing; there will be a choice residence section around Central Park and a great city north of the Harlem River, but *the* home of the vast multitude which is soon to be centered at this metropolis will be on the western end of Long Island, as nature evidently intended, since it left no other place for them.

Are Local Passenger Rates too High?

The Ohio Legislature has been wrestling with a bill proposing to reduce all passenger rates in the State to a maximum of two cents per mile, and the debates and discussions over it have called forth the usual amount of profound nonsense and utter disregard of the property rights of railway owners from newspaper logicians. The Cleveland *Leader* says:

"Why is it that the average rate per passenger per mile in this State is only 2.1 cents? Is it because the local business in the State, comprising at least 50 per cent. of the total, is religiously maintained at 3 cents a mile, or is the average dragged down because there is a constantly growing cheap class of business such as excursions and commutations, which will not average a cent a mile? And is not this latter class of business profitable? If not why is it encouraged. The Nickel Plate road, which, in comparison with the aggregate earnings, does a larger cheap excursion business than any in the State, has demonstrated to a certainty the value of that class of business. A portion of the Nickel Plate runs through a very thinly settled region, but the policy of cheap excursions has developed such a habit of traveling among these sparse settlers that a rich pecuniary reward is reaped by the company every year at a rate considerably less than a cent per mile. Other varieties of cheap travel are equally valuable to the railroads and thrive proportionately as they are encouraged." * * * * * "Suburban travel is an instance. People engaged in business in a city will not take up a residence in a suburb unless special low rates are granted. The companies recognize this, and make the low fares."

The argument of the writer, the whole of which we have not space for, seems to be, that because excursion and commutation rates are profitable at less than a cent per mile that every reduction is profitable, and that the only reason why local rates are high is the desire of the company to practice extortion. This fallacy is so common a one and its results are so dangerous that it seems worth while to point out its error. It must first of all be admitted that the only just basis for fixing the rates for the different kinds of service must be their cost to the railroad company. Now when the fact that local fares are the highest of passenger fares is grumbled at, the passenger should remember this: That what he pays for is not only the safe transportation of himself and baggage so many miles, but also the privilege of being able to make that journey at any time he chooses. In other words, in running suburban commutation trains the railroad company is sure of well filled trains every day with little variation; excursion trains are generally run only as specials; but the trains which carry the local passenger traffic run sometimes with not passengers enough to pay the trainmen's wages. When local passengers are content to travel at such times only as the railroad company's convenience permits and are willing to dispense with a regular train service, the railways may afford to carry them for a cent or less a mile. The facts are that as a general rule the suburban rates and excursion rates are actually much higher in proportion to the cost of service than the local passenger rates.

PERSONAL.

EDWARD D. BOLTON, for 13 years principal assistant engineer in the office of E. W. BOWDITCH, of Boston, has become a partner in the firm of T. Wm. Harris & Co. The firm intends to make more of a specialty of surveys, plans and estimates for waterworks, sewers and public improvements, and at the same time continue in the present extensive contracting business. It is expected to build a large amount of water-works and sewers during the coming season.

THOMAS J. POTTER, Vice-President and General Manager of the Union Pacific Ry. Co., died at Washington, D. C., March 9. He was born in Ohio, Aug. 16, 1840, and joined an engineer corps on the Burlington & Missouri River R. R. in 1861. He filled different positions on this road till 1873, when he entered the service of the Chicago, Burlington & Quincy R. R., where he remained till 1887, in which year he went to the Union Pacific Ry.

WM. H. WILEY, the well known technical publisher, and an active member of all three of the leading engineering societies, has been proposed as American Commissioner to the Paris Exposition of 1889, a post for which he would certainly seem to be well qualified, if he is willing to accept it.

The Delaware Breakwater.

The Delaware Breakwater, located at the entrance into Delaware Bay is the largest work of its kind in this country, and although inferior in extent to the Cherbourg is superior in linear dimensions to the Plymouth breakwater. From some data recently compiled in regard to it we extract the following:

Under the act of Congress of May 7, 1822, an appropriation was made for a survey of Delaware bay near Cape Henlopen, for the purpose of determining upon the site for a harbor of shelter. In 1828, an appropriation of $250,000 was made for inaugurating the work under a plan submitted by a Board of Commissioners appointed by Congress.

The project of the Board contemplated the construction in the concavity of the bay just inside of Cape Henlopen, of two massive works on the *pierres perdues*, or riprap system, separated by an interval of about 1,400 ft.: the greater, called the breakwater, to afford safe anchorage during gales from the north and east; the other, called the ice-breaker, to protect the shipping from northwesterly gales and the heavy drifting ice of Delaware Bay.

The site of the works was in water about 30 ft. deep; and their foundation a compact and quite stable sand bottom.

The works as projected in 1828, were completed in 1869, at an aggregate cost of $2,192,103. The stone used in their construction was mainly granite and gneiss and in masses varying from 500 lbs. to 7 tons in weight; the smaller forming the mass of the work, the larger, covering the exterior slopes and the tops.

A recent careful study of the present sections of the breakwater and ice-breaker gave the following results: The breakwater has a length of 2,558 ft., the ice-breaker a length of 1,360 ft. on top; on the ice-breaker the mean slope on the harbor side is 1 vertical upon 1.3 horizontal, and on the outer, or sea face, a slope of 1 vertical on 2 horizontal; the breakwater, which is more directly subjected to wave action and upon which the sea slope was possibly placed flatter than in the case of the ice-breaker, has, upon the harbor side, a mean slope of 1 vertical upon 1 horizontal and on the sea face a slope of 1 vertical upon 2.2 horizontal above mean low water, and 1 vertical on 2.8 horizontal from mean low water to the bottom.

The mean dimensions are as follows: The ice breaker has a top width of 22 ft., a bottom width of 156 ft. and a height of 40 ft.; the breakwater has a top width of 22 ft., a bottom width of 176 ft. and a height of 42 ft. The top of the works are from 12 to 14 ft. above mean low water; the amplitude of normal tides about 5 ft.

The combined volumes of the ice-breaker and breakwater, including void spaces, is 593,000 cu. yds. The stone placed in the works was paid for by weight and covered 892,528 gross tons, or about 441,000 cu. yds. of solid stone.

From this it will be seen that the void space is 154,000 cu. yds. or 34.7 per cent. of the solid stone, and 26 per cent. of the entire volume of the works. This low percentage of void space, probably arises from the long interval of 41 years, during which the work of depositing the stone was in progress, allowing of a thorough compacting of the volume by settlement and the action of the waves.

The entire cost of the work was at the rate of $2.46 per gross ton, or $3.60 per cu. yd. of volume. The cost per linear foot of work was about $560; if the ice-breaker be considered as simply an auxiliary to the breakwater, and the entire cost of both works be divided by the length of the breakwater, the resulting cost will be $857 per lin. ft. The cost of the Portland Breakwater was $750; the Alderney, $950; the Cherbourg, $1,100; the Plymouth, $1,500, and the Dover, $2,075 per lin. ft.

Work is now in progress in closing the gap previously existing between the end of the ice-breaker and the breakwater; when this is completed the breakwater will have received an additional extension of about 1,400 lin. ft.

ENGINEERING NEWS.

An engineer in the Argentine Republic writes as follows:

"I am in receipt of many letters from engineers who seem to think that this must be a paradise for them. While we need good men here and to such pay good salaries, I would not advise engineers to come here unless they come for specific work. The language is a great drawback, much more than in Mexico, where one had only to deal with the people sufficiently to get meat and bread, while here all the companies, with an exception or two, are native, and an engineer must be to a certain extent familiar with the lingo or accept what he can find, *i. e.*, subordination. Though I think for those that try, there is a certain brilliant future here.

"The financial policy of the country is as sound as could be expected. The country is quiet and will be, at least, to the end of the present administration (4 years hence). The production is marvellous and the resources of the country are to a certain extent unequaled anywhere. The climate is much like that of the uplands of Mexico, somewhat cooler in winter and but a trifle more trying in summer."

A GENIUS known as TREAT T. PROSSER, of Chicago, Ill., if he be not belied in the Chicago *Tribune*, which devotes a long article to the matter, has invented a very extraordinary form of steam engine which has attracted the usual attention from capitalists, and which remedies the lack of economy of the "ordinary form" by *burning the exhaust steam*, as nearly as we can make out, after separating it into its constituent elements of oxygen and hydrogen. As the non-economy of the ordinary steam engine results almost wholly from the exit of this steam as steam from the cylinders, and as the "ordinary form" of boiler utilizes in steam from 50 to 75 per cent. and sometimes even more of the theoretical evaporative efficiency of the coal we fail to see much hope in this direction for any radical improvement.

THE 19th quarterly report of the Government inspectors of the Forth bridge has been presented to Parliament.

The riveted work at South Queensferry now amounts to about 4,880 tons, showing an addition of 866 tons during the quarter; the riveted steel work at Inchgarvie to 5,817 tons, being an addition of 1,105 tons; and steel work at North Queensferry about 5,407 tons, showing an increase of 1,112 tons during the quarter. Up to the present date about 566,500 cubic ft. of granite have been delivered and 562,000 cubic ft. set; and about 111,600 cubic ft. of rubble masonry and concrete work built. In all, about 46,740 tons of steel, an addition since last report of 1,578 tons, have been delivered. The average number of men em-

ployed per day has been 3,790. Eight fatal accidents occurred among the workmen during the quarter, none of which, however, were due to any failure of plant, such as have caused accidents in previous quarters.

IRRIGATION IN THE PUNJAB.—The irrigation canals of this region are divided into two classes, the perennial or constant type and those which store and distribute the inundation water only. Of the first class there are 1,330 miles of main canals and ,034 miles of distributers ;of the latter there are 2,440 miles of canal and 641 miles of distributing canals. In 1886-87, the perennial canals irrigated 1,011,061 acres, and the inundation canals watered 939,579 acres, a total of 1,950,640 acres. The crops produced are sugar cane, rice, cotton and wheat, the last covering an area of 747,514 acres in 1887; this is the largest on record.

PUBLICATIONS RECEIVED.

Report of the Chief of the Bureau of Statistics on the Commerce and Navigation of the United States, for year ending June 30, 1887. Part I: Foreign Commerce, Immigration and Tonnage.

A Manual of the Principal Instruments used in American Engineering and Surveying, manufactured by W. & L. E. GURLEY, Troy, N. Y. 27th Ed. 362 pp. 72 cuts and insets.

This familiar manual has been very extensively revised and is a really excellent reference book on instruments. The new opera glass hand level strikes us as an admirable instrument, a great advance on the Locke level (which of course it resembles in principle) and but little more costly.

A new and revised edition of ARTHUR JACOB'S "The Designing and Construction of Storage Reservoirs," No. 6 of the Van Nostrand Science Series), is in preparation. There will be much new matter by E. SHERMAN GOULD, Esq., of Scranton, Pa., and the entire revision of the work will be by him also. Mr. GOULD'S connection with the Croton Aqueduct, of New York, and with similar works, will render this little manual an authority upon the subject of reservoirs for storage purposes

Sewage Treatment Purification and Utilization, by J. W. SLATER. A Practical Manual for the Use of Corporations, Local Boards, Medical Officers of Health, Inspectors of Nuisances, Chemists, Manufacturers, Riparian Owners, Engineers and Rate-payers. 12 mo. cl. London, 1887. Price, $2.25.

This book is one of the elect. It is written by a man who knows what he is writing about, and to all interested parties our advice is—buy it.

The "*Transactions of the American Society of Civil Engineers*," for June, July, August and September, contain papers:

360. A Masonry Dam; by JOHN W. HILL.

361. Steel. Its Properties, its Use in Structures and Heavy Guns; by WM. METCALF.

362. Annual Address; by WM. E. WORTHEN.

363. Calculation of the Stresses in Bridges: by GEO. F. SWAIN.

364. Compressive Strength of Iron and Steel; by CHAS. A. MARSHALL.

365. The Kentucky and Indiana Bridge; by MAX MOULTON.

SOCIETY PROCEEDINGS.

Engineers' Club of Philadelphia.—Record of Business Meeting, March 3d, 1888. President JOSEPH M. WILSON in the chair; 34 members and 3 visitors present. Rules to facilitate the discussion of papers, as formulated by the Publication Committee, were adopted as follows:

1. That the author of any paper who may desire a discussion thereon, may submit his MS. to the Publication Committee not later than 15 days prior to the date of the meeting when such paper is to be presented or read.

2. If approved, said paper shall be immediately set up in galley and as many copies as the author may desire, not to exceed 25, be sent to him for distribution amongst those Members who, he may believe, would desire to discuss it. A copy may also be posted on the bulletin of the Club.

3. As soon after the meeting as practicable, the paper, with so much of the discussion as may be presented in writing by those taking part therein, shall be printed in uniform size for the Proceedings, with the consecutive folio numerals, and the author may order at once as many extra copies as he may desire, for the cost of corrections, paper and press work. The regular edition shall be struck off at the same time.

4. As soon as a sufficient amount of material is collected to form a number of the Proceedings, it shall be bound and issued as heretofore.

5. Papers not requiring discussion may be presented as at present, at any meeting, and will be printed as soon as ready in their regular order.

The following members were elected:

Active Members: Messrs JAMES G. DAVIS, EDWIN S. CRAWLEY, THEODORE KOLISCHER, JAMES B. BEST, FRED. STAMM, WM. D. JANNEY, GUSTAF BOTTIGER, R. I. D. ASHBRIDGE, JOHN BAPTIST NAU, S. PEMBERTON HUTCHINSON and JOS. D. POTTS.

Associate Member, JOHN GORDON GRAY.

The resolution to the effect that the Club approve and adopt the 24 hour system of time notation, offered by AMASA ELY and others at Business Meeting, February 4th, 1888, and laid over for consideration at this meeting, was, on motion, laid on the table.

Prof. L. M. HAUPT, of the Library Committee, reported progress in the arrangement of the Library.

Mr. HENRY G. MORRIS submitted correspondence in relation to his criticism on the Construction of Elevators at the last meeting of the Club, and desired to correct the statement made by him, at that time, in relation to the size and character of bolts which he referred to, as they were found to be through bolts of 1-in. diameter. He declines, however, to admit that it was good construction to locate the bearings of counter-balance shaft as had been done, when they might have been placed in a safer position.

The Secretary presented, for A. WELLS ROBINSON, a set of copies of drawings of various forms of Dredging Machinery. C. HENRY RONEY described the Printing Telegraph Apparatus of the International Printing Telegraph Co. Specimens of the work of the instrument were exhibited. MORRIS P. JANNEY described an Electric Water Level Indicator, for steam boilers, exhibiting a specimen arranged so as to work as when in actual operation.

HOWARD MURPHY, *Sec. & Treas.*

Engineers' Club of St. Louis.—The club met at Washington University, March 7, President HOLMAN in the chair, 29 members and 5 visitors present. The minutes of the last meeting were read and approved. The executive committee reported the doings of its last meeting. The special order of the day was then taken up, being the report of the committee on the Waddell pamphlet on highway bridges. After a general discussion participated in by Prof. JOHNSON, Col. MOORE, Prof. ENGLER, Messrs. SEDDON, BOUTON, WHEELER and others, the following substitute was adopted:

Resolved, That the Engineers' Club of St. Louis do not deem it advisable to endorse any individual specifications.

The president announced the death of FREDERICK SHICKLE, one of the charter members of the club, and a committee was appointed to draft suitable resolutions. Prof. POTTER, late president of the club, having been elected to the presidency of the American Institute of Mining Engineers, it was voted to tender him a complimentary banquet at such time and place as would suit his and the club's convenience; also that a committee of three be appointed to complete the necessary arrangements and have final charge of the matter.

Prof. GALE then read a paper on "Transmission of Power by Belting," giving the results of some recent experiments; also a formula for calculating the width of belt for a given power. An empirical formula which had been found correct up to 5,000 ft. belt speed per minute, was given. Results of tests of various kinds of belts on iron and lagged pulleys were also given. Samples of the belts tested were shown. The paper was illustrated by sketches and discussed by Messrs. BARTLETT and SEDDON. Owing to the lateness of the hour, it was voted to postpone Mr. BURNET'S paper to the next meeting. Adjourned.

W. H. BRYAN, *Secretary.*

Engineers' Club of Kansas City.—A regular meeting was held March 5. A letter to the Committee of National Public Works from Mr. JOHN EISENMANN, Secretary of the Council, requesting action to be taken by the Club was read, also one from E. L. CORTHELL, President, thanking the Committee for their liberal subscription to defray expenses of the Council. The report to the Council on the H. R. Bill No. 4,923 by the Kansas City Committee was read, and a report by the same Committee to the Club in which it was recommended that the Club pass resolutions to endorse the said bill and that they co-operate with the other societies in promoting it. The report was adopted and the resolutions endorsing it, which were read at the previous regular meeting, were approved, the Secretary being directed to forward them to our Representative in Congress.

The paper of the evening, "Engineers' Field Books," was read by Mr. EDWARD BUTTS, being a review of this class of literature. The author then presented the Club with a copy of "Butts' Engineers' Field Book," upon which, by motion of Mr. TALMAGE, he was accorded the thanks of the Club.

KENNETH ALLEN, *Secretary.*

RECORD OF NEW WATER-WORKS CONSTRUCTION.

(*Specially Communicated.*)

(CONTINUED FROM PAGE 193).

Auburn, Cal.—The works were commenced Oct. 10, 1887, and approved by the Board of Supervisors, March 1, 1888; they were designed by F. BIRDSALL of Sacramento, and WM. AMBROSE, of Auburn, was Constructing Engineer. The buildings were erected by J. Davis, of Auburn; the pipe, specials, valves and hydrants were supplied by W. W. Montague & Co., of San Francisco. There is a reservoir with a capacity of 2,000,000 galls., at a height of 350 ft. above the town. The trenching and pipe laying was done by white men working by the day. $2 per day for laborer. The works are owned by the Auburn Water-Works Co. F. W. BIRDSALL is Superintendent. The present population is 2,600.

Circleville, O.—The works were commenced in March, 1887, and accepted Dec. 1, 1887; they were designed by E. F. FULLER, of New York, who was also Constructing Engineer for the contractors, Samuel R. Bullock & Co., 11 Wall St., New York. The pumping machinery was supplied by the Holly Mfg. Co., Lockport, N. Y.; the pipe and specials by Dennis Long & Co., Louisville, Ky.; the valves and hydrants by the Ludlow Valve Co., Troy, N. Y.; the stand-pipe (150 ft. high) by Tippet & Wood, Phillipsburg, N. J. The franchise is for 30 years, price per hydrant $35 per annum; it is owned by S. R. Bullock & Co. The works are managed by the Circleville Water Supply Co. There are 10 miles of 6-in. to 16-in. pipe; 102 hydrants in the city. The water is taken from a filtering gallery built on bank of Darby creek, also from a storage reservoir with a capacity of 14,000,000 galls., and pumped to a stand-pipe 22 ft. diameter and 150 ft. high, by Holly-Gaskill direct acting engines with a daily capacity of 3,000,000 galls. The present population is estimated at 8,500.

Woodstock, Vt.—The works were commenced in June, 1887, and have not yet been accepted; they are nearly completed. They were designed by J. J. R. RANDELL. The contractors are R. D. Wood & Co., Philadelphia, and T. Wm. Harris & Co., New York, the former having the contract for the entire works. There is an elevation of 260 ft. and a pressure of 115 lb. The franchise is for 5 years, and the price per hydrant $35 per annum. The franchise is owned by the Woodstock Aqueduct Co.; President, F. N. BILLINGS; Secretary, H. C. PHELPS; Treasurer, F. W. WIEDER. The population of the village is 1,500, and of the town 3,000.

Green River and Rock Springs, Wyo.—(CORRECTION).—Referring to our description of these works, on page 146, Mr. E. C. KINNEY writes that the lengths of pipe should be 17 miles of main line and 5 miles of distribution. It has also been decided to use lead service pipe instead of galvanized iron.

TO BE CONTINUED.

CONSTRUCTION NEWS.

RAILROADS.

East of Chicago.

Existing Roads.

Newfoundland.

ST. JOHNS, Newfoundland, Feb. 29, 1888.

EDITOR ENGINEERING NEWS:

During the year 1887 the Newfoundland Railway was extended from Harbor Grace Junction towards Placentia, a distance of 12 miles, and the remainder of the line to Placentia, 14½ miles, is in process of construction. H. C. BURCHELL, Col. Gov't. Engineer.

Grand Trunk.—The Massena Springs & Fort Covington Railroad, connecting this system with the Rome, Watertown & Ogdensburg at Massena Springs, N. Y., was completed March 9. The new line is about 23 miles in length.

International.— This extension of the Canadian Pacific system, now in process of construction across northern Maine to Mattawamkeag on the Maine Central, it is now reported will not stop at Mattawamkeag as was proposed, but will be extended from that point to St. Andrews, New Brunswick, just across the International boundary. This will be made the terminus and chief export port of the Canadian Pacific system;

Pittsburg, Shenango & Lake Erie.—Track has been laid on this road in Western Pennsylvania to Amasa Crossing and grading is in progress toward Girard. It is reported that the company are considering Conneaut, O., for a lake terminus instead of Erie, Pa.

New York & New England.—Surveys are in progress for a branch road from Needham to Readville, Mass., to be built for the purpose of running the trains on the Woonsocket division into Boston over the company's line instead of over the Boston & Albany as at present. The branch is about four miles in length.

Pennsylvania.—The following figures are from the annual report for 1887.

Gross earnings	$115,515,506
Operating expenses	77,238,082
Net earnings	38,277,424
Tons of freight carried	106,128,215
Total passengers carried	68,154,206

Hartford & Connecticut Western.—It is reported that the owners of this company, who are also interested in the Poughkeepsie bridge, are negotiating with the Boston & Maine managers for a connection with the Central Massachusetts and a direct line to Boston.

New Projects and Surveys.

Maine.—A charter will be asked from the next legislature for a railway from Biddeford to Kennebunkport, and surveys are to be made during the coming spring.

Pennsylvania.—A project is on foot at Williamsport, Pa., to build a railroad 6 miles in length from Eaglesmere on the Williamsport & North Branch road to Lake Mokoma in Sullivan county.

Baltimore & Lake George.—This company has asked the Maryland legislature to grant it enlarged powers beyond that given by its charter. The incorporators are CLINTON MCCULLOUGH, GRIFFIN W. GOLDSBOROUGH, PHILIP W. DOWNES, and others.

SOUTHERN

Existing Roads

Farmville & Powhatan.—

703 *East Main St.*
RICHMOND, Va., March 12, 1888.

EDITOR ENGINEERING NEWS:

The Farmville & Powhatan Railroad is to run from Bermuda Hundred to Farmville, on the Norfolk & Western Railroad, a distance of 99 miles. Contracts have been let to Van Doren & Strother, Powhatan C. H., Va., and 16 miles have been graded. The contract date for completion is March 1, 1889. Trackla ying will probably begin in September, 1888, and a part of the line will be opened for traffic by Jan. 1. The location has been completed for 40 miles and the right of way is all secured. The company has leased the Bermuda Hundred railway. The road is being constructed by the Bermuda Hundred Construction company. Three hundred men are now at work and the capital needed to purchase right of way and prepare the roadway for ties has been raised by cash subscription and county bonds, subscribed in lieu of cash. No bonds have been offered for sale. JAS. HOBSON, of Rock Castle, Va., is President and H. A. WHITING, Powhatan C. H., Chief Engineer. JAS. R. WERTH.

Cumberland Valley.—Chief Engineer CHAUNCEY IVES has begun the survey for the extension of the Martinsburgh & Potomac railroad from Martinsburgh to Winchester, Va. This extension has been under consideration for a long time, and it is now believed that it will be put through this season.

Central R. R. of Georgia.—The company has under consideration several routes for a line from Savannah to Americus, Ga. The first is an air line from Eden to Perry; the second, a line from Eden to Buena Vista; the third a line from Eden direct to Americus. Two corps of surveyors have been put on these lines, and surveys are also in progress from Buena Vista to Columbus. Several additional corps of surveyors are likely to be sent out soon. President ALEXANDER states that in case the Atlanta, Atlantic & Great Western road is built, the Central will build 57 miles of new lines to shorten its route from Savannah to Atlanta. These cut-offs would run from Sandersville to Milledgeville, and from Eatonton to Covington.

Nashville & Tellico.—Grading is finished on the first 10 miles of this Tennessee road and tracklaying has begun. The 22 miles from Athens to Tellico will be finished this season.

Memphis & Charleston.—A decision will soon be made in regard to the building of the extension from Stevenson, Ala., to Chattanooga, Tenn., for which most of the surveys were made last year. The company at present uses the tracks of the Nashville, Chattanooga & St. Louis, but the contract expires next fall.

New Projects and Surveys.

Kentucky Midland.—

FRANKFORT, Kentucky, March 6, 1888.

EDITOR ENGINEERING NEWS:

Over 80 miles of the Kentucky Midland have been surveyed and located. The line is expected to extend from Frankfort *via* Georgetown, Paris and Owingsville, a distance of 150 miles to a connection in eastern Kentucky with some one of the Virginia roads leading to the seaboard. The surveyors are now at work, right of way is being secured, and contracts for building will be let within the next four weeks. Capital for building has been partly secured by county subscriptions. Work and grades on the line are medium and there are no large bridges or tunnels. J. M. DOUGLAS is Chief Engineer.

WM. LINDSEY, *President.*

Alabama Midland.—This company has secured a large amount of local aid and J. W. WOOLFOLK of Montgomery, the chief mover in the enterprise, states that work will probably be begun in 60 days.

Kentucky.—The bills have been passed incorporating the following railway companies. Central Valley, Licking & Little Sandy, Lexington & Madison, Clifton & Reservoir Park, Vincennes, Oakland City & Owensboro.

THE NORTHWEST.

Existing Roads.

Chicago, St. Louis & Paducah.—This extension of the St. Louis, Alton & Terre Haute system to Paducah, Ky., is now all under contract, the Brooklyn division having been awarded to N. W. Irish, of Carlyle, Ill., on March 8. The whole will probably be completed in October. Col. E. W. MUENSCHER is Chief Engineer.

Chicago, Milwaukee & St. Paul. A press dispatch from Mason City, Ia., states that "Maj. Allen" has been awarded a contract for building an extension of 170 miles from Chamberlain, Dak., toward the Black Hills. It is also reported that a line from Spencer, Ia., to Sioux City, about 75 miles, will be built this season.

Duluth & Iron Range.—Grading is reported nearly complete on the extension from Tower to Chandler Mine, and tracklaying will begin at once. It is expected to have the line open to Ely by May 1.

New Projects and Surveys.

St. Paul, New Ulm & Southwestern.—

CARVER, Minn., March 7, 1888.

EDITOR ENGINEERING NEWS:

Our line is projected to run from St. Paul and Minneapolis *via* Chaska, Carver, and New Ulm, with a branch to St. Peter and Mankato, about 120 miles. Right of way is now being secured through the towns, and we expect to begin surveys in April. There will be one large bridge over the Minnesota river. It is expected that the enterprise will be backed by some other Ry. Co. in whose interest it is projected. We hope to begin tracklaying in June and complete the line by Jan. 1, 1889.

W. C. BREDENHAGEN, *President.*

St. Paul & Minneapolis Rapid Transit.—This company is still seeking permission to build and operate its proposed line from the City Councils. The line is to be an elevated structure, and it is hoped to begin work this season. J. P. MOORE, of St. Paul, is interested.

Chinook Belt & Peace River.—This proposed line is to run from the Canadian Pacific main line to Edmonton and the Peace river country. A charter has been asked from the Canadian Parliament.

THE SOUTHWEST.

Existing Roads.

Missouri Pacific.—Maj. B. S. WATHEN, Chief Engineer of the lines of this system in Texas, favors us with the following corrected statement of the work completed and in progress. Track was laid during 1887 from Gainesville to Henrietta, 70 miles; from San Marcos to Lockhart, 16 miles; from Bastrop to New Ulm, 55 miles. Lines are now in process of construction from Lockhart to Smithville, 36 miles; from New Ulm to Sealy, 23 miles; and from Dallas to Hillsboro, 66 miles. There are two large bridges, one 460 ft. long over the Colorado river near Bastrop, and one 440 ft. long at La Grange.——The Kansas and Arkansas Valley line has been completed from Van Buren towards Gibson, Ind. Ter., a distance of 20 miles. The bridge over Grand river at Fort Gibson has been completed.——A Texas report states that a new Gulf terminus is to be obtained at the mouth of the Brazos river. The bar at the mouth of the river is to be dredged out and the Columbia branch is to be extended to the mouth of the river.

Kansas City & Pacific.—A correspondent favors us with corrections of our data regarding this Kansas road, stating that the road is now in operation from Coffeyville to a point 3 miles east of the town of Selma in Anderson County, a distance of 33 miles. Surveys have been made and the road located from the present terminus to Paola in Miami County, a distance of 30 miles, and from Paola, northeastwardly in the direction of Belton, Jackson County, Mo. The company has not yet determined whether it will run from Paola to Kansas City over the Kansas City, Fort Scott & Gulf Railroad under trackage agreement, or extend to Belton and reach Kansas City over the tracks of the Kansas City & Southern Railroad. The road may also be built from Paola about due north to Gardner on the Southern Kansas Ry., and reach Kansas City over 34 miles of the tracks of that road. Whichever course is pursued, the Kansas City & Pacific will be practically as independent as if it built a new line of its own to Kansas City. W. H. WOOLVERTON, President of the New York Transfer Co., is President, and C. H. KIMBALL of Parsons, is Vice-President.

Chicago, Rock Island & Pacific.—A preliminary survey under direction of E. L. PRESTON has been completed from Caldwell, Kan., to Cisco, Tex., and the surveying corps have returned to Topeka. The people of Cisco were much elated over the arrival of the surveyors and began to boom their real estate at once. It may be doubted, however, whether the Rock Island will do much upon a Texas extension during the coming season, though the system will doubtless be extended in that direction as soon as good judgment permits.

Denver, Texas & Fort Worth.—Work on the completion of this line has been somewhat delayed, but according to the latest reports which reach this storm-bound city the last rail was to be laid on March 15.

New Projects and Surveys.

Omaha, Garden City & Pacific.—Chartered in Kansas with a capital stock of $7,000,000 by GEO. E. MORGAN and others of Garden City.

Interstate & Denver.—This Kansas company has elected GEO. GOULD of New York, President, and DAVID KELSO of Parsons, Treasurer. As noted in our issue of Mar. 3, the line is likely to be built by the Missouri Pacific system.

Texas.—A project is on foot for a railway line from Gonzales to New Braunfels.

ROCKY MOUNTAIN & PACIFIC.

Existing Roads.

San Diego, National City & Otay.—

NATIONAL CITY, Cal., Mar. 5, 1888.

EDITOR ENGINEERING NEWS:

During the year 1887, track was laid on this road from San Diego to Oneonta, 16.45 miles, and from National City to Sweetwater Dam, 6.02 miles. The tracklaying on the extension from Sweetwater Dam to La Presa was finished on March 3d and the line from Otay to Tia Juana, at the Mexican Boundary, is now under construction. A line is also proposed from La Presa to El Cajon, a distance of 6 miles. Our road is a lightly equipped standard gauge railway, using 17 ton engines. Both freight and passengers are carried and the company is doing a fine traffic and paying dividends.

JAS. D. SCHUYLER, *Chief Engineer.*

Arizona Mineral Belt.—

West Adams St., LOS ANGELES, Cal., Mar. 1, 1888.

EDITOR ENGINEERING NEWS:

Find map enclosed showing line of the A. M. B. R. R. A preliminary line has been run from Flagstaff to Globe, distance 180 miles. The road is now built 36 miles from Flagstaff south and two more miles are graded, bridged and tied ahead of track. Ties are also delivered for five miles farther. The road is in good working order and is doing a good business.

A. A. MCDONNELL, *Vice-Pres. and Supt. of Construction.*

Prescott & Arizona Central.

PRESCOTT, Ariz., March 1, 1888.

EDITOR ENGINEERING NEWS:

Our extension from Prescott to Phœnix, 110 miles, is now under survey and will be built this year.

A. S. BULLOCK, *President.*

Southern Pacific.—Work is in progress on the line east of Visalia, Cal. The bridge across King's river is finished and surveyors are setting the final grade stakes. The Shingle Springs & Placerville road has been completed. The force which has been employed on this line has begun work on the double tracking between Oakland and Port Costa. Vice-President CHARLES CROCKER is reported by the San Francisco *Call* to have stated that the company will build large shops near Los Angeles. Plans are also in preparation for additions to the offices at San Francisco and the Sacramento shops. The line from Templeton to Santa Barbara and the extension to San Diego are to be built, though Mr. CROCKER said that definite plans had not yet been decided upon. The proposed branch from the California & Oregon into Eastern Oregon to a connection with the Union Pacific system is again rumored.

Santa Ana, Fairview & Pacific.—It is reported that grading is in progress on this short line in southern California. A. L. CLARK, of Santa Ana, is interested.

Chicago, Rock Island & Pacific.—The visit of President M. A. Low to Colorado Springs and Pueblo has excited renewed interest in the extension to Pueblo, and it is stated that he has asked a grant of terminal facilities from the two cities. Another report is to the effect that the company has made a contract with the Denver & Rio Grande not to build to Pueblo or Denver. The former state of affairs is, however, the most likely one.

San Francisco & Northern Pacific.—The Cloverdale & Ukiah extension, about 30 miles in length, is being rapidly pushed by a force of about 1,500 hands. The work is about one-half completed, and it is expected to be finished by July 1. Of the five tunnels on the line, tunnel No. 1, 350 ft. long, is finished. In No. 2 which will be 1,850 ft. long, 60 per cent. of the work is done. No. 3 will be 250 ft. long, and is just commenced. No. 4 will be 1,250 ft. long and over one-third is finished. This tunnel is through a solid rock almost its entire distance, and requires no timbering. The contractors are making from 120 to 150 ft. a month in each end. No. 5 will be commenced after the completion of No. 3 about April 1st. It is about 400 ft. long.

Atchison, Topeka & Santa Fé.—The rumors are still circulating that this company is back of the San Francisco & San Joaquin Valley enterprise which, according to some reports, has finished the grading on

about a hundred miles of the proposed line from Mojave to San Francisco and according to other and more probable statements has merely thrown up a low bank of earth which is but the beginning of what will have to be done in order to construct a railroad over the route they have chosen. Another report states that the company has purchased 19,000 acres of land on San Francisco bay on which it will build extensive freight terminals.

Oregon Railway & Navigation Co.—Much interest is felt in the suit which has been brought to restrain the joint lease of this system to the Union Pacific and Northern Pacific systems.

New Projects and Surveys.

Visalia & Tulare.—This dummy road at Visalia, Cal., 10 miles in length, is under contract to Maples of Tulare. The contract price is $5,000 for the grading.

Fresno, Belmont & Yosemite.—

FRESNO CITY, Cal., Feb. 27, 1888.

EDITOR ENGINEERING NEWS:

Our road is to run from Fresno City, Cal., north and northeast about 50 miles. The line has been partially surveyed, right of way is secured and also part of the capital for construction, and it is expected to let contracts during the present month. Grades are light for 20 miles, but the remainder is heavy. The line is a local road having no connection with others and is to be built as the demand requires. I. TIELMAN is Chief Engineer. E. C. WINCHELL, *President.*

Del Mar & San Diego.—This company has been incorporated in California to build a railway from Del Mar to San Diego. The capital stock is $200,000. FRANK J. HIGGINS of San Diego is interested.

Philipsburgh & Granite Cable.—This company has been organized at Philipsburg, Montana, to construct a railway between the points named in the title.

White Oaks.—C. F. HAMILL and HENRY L. NEWMAN of St. Louis, are reported to have purchased the franchise for this proposed New Mexico road. The line is to extend from El Paso to the Texas Panhandle.

Central Washington.—Incorporated in Washington Territory to build a railroad from some point on the line of the Northern Pacific in Spokane or Lincoln counties, to the "Big Bend country." The charter is filed by JAS. B. WILLIAMS of New York, THOS. F. OAKES of the Northern Pacific company, and others.

Bridges and Canals.

The Halifax River Bridge & Street Railway Co. has been organized at Daytona, Fla., by H. P. HAND F. L. RODGERS, and others. Capital stock, $10,000.

The New York & New Jersey Bridge Co., which proposes to bridge the Hudson at Washington Heights, has amended the bill of incorporation so as to provide that the company may sell the bridge to any railway company, or sell a portion of the stock to it.

The Wabash Bridge & Ferry Co. has been incorporated by M. A. ODRICK, J. CASTELLO, W. L. LINCOLN, and others, of Wabash, Minn., to build a bridge across the Mississippi. Capital stock, $20,000.

Bridge Notes.—*New London, Conn.*—It is reported that the New York, Providence & Boston R. R. Co. will shortly commence work on the Thames river bridge.

Harrison, N. J.—Another bridge is projected to be built across the Elizabeth river to Newark. Estimated cost, between $75,000 and $100,000.

Poast Town, O.—The County Commissioners, Hamilton, O., will build a bridge across the Miami river at a cost of about $30,000.

Indianapolis, Ind.—The County Commissioners will build a bridge over White river, west of North Indianapolis. It will be an iron structure, with 2 spans of 175 ft.

Randolph, Mo.—A free wagon bridge across the Missouri is proposed. J. A. L. WADDELL, of Kansas City, estimated that an iron truss bridge, strong enough for a cable line, could be built for $160,000. Mr. DIES, of Liberty, submitted a plan for a pontoon bridge similar to the one in use for several years at Prairie du Chien, Wis.; the cost would be about $3,000.

Denver, Col.—The County Commissioners will build a bridge across the Platte river.

Dagget, Cal.—An iron bridge across the Mojave river has recently been completed by the San Francisco Bridge Co.

Vernon, Tex.—An iron bridge is to be built across the Pease river for the County Commissioners. It is said that the site is ill chosen and that the bridge and approaches will not stand the freshets. The King Iron Bridge & Mfg. Co., of Cleveland, O., has the contract at $50,000. There will be 400 ft. of iron truss spans; the total length of the structure will be 2,100 ft.

Montreal, Canada.—Plans for the proposed bridge from Montreal to Longueuil, across St. Helen's island, have been prepared by HENRI MALINGUE, C. E.

Contracting.

Pipe and Hydrants.—The following proposals have been received by the Board of Public Works, Lincoln, Neb.: Ohio Pipe Co., Columbus, O., $31.43 per ton for pipe, 3 cts. per lb. for castings; Dennis Long & Co., Louisville, Ky., $22.90, 3 cts. The contract was awarded to the Ohio Pipe Co. The contract for Adams hydrants and 6-in. valves, was awarded to F. C. Sholes.

Excavation and Masonry.—The following proposals have been received for work at the new engine house, Roanoke, Va.: Simmons & Winch, $2.75 per cu. yd. for masonry, 20 cts. per cu. yd. for excavation; I. H. Bachrach, $2.60 and 25 cts.; J. Shrister, $2,90 and 25 cts.; C. M. Ryan, $2.80 and 20 cts.; B. B. Dull, $2.69 and 15 cts.; W. H. Mason, $3.10 for masonry, including excavation.

Pipe and Specials.—The following proposals for cast-iron water pipe and specials for 1888, and separate bids for 8,350 ft. of 30-in. pipe and castings, were received March 6 by JOHN WHITELAW, Superintendent and Engineer of the Water-works, Cleveland, O.: R. D. Wood & Co., Philadelphia: 3-in., $31.20 per ton of 2,000 lbs.; 4-in., $28.80; 6 and 8-in., $28.20; 10 and 12 in., $27.80; 30-in., $26.95; Lake Shore Foundry, Cleveland, O., 3 to 16-in. pipe, $26.50; 3 to 16 in. specials, 2¾ cts. per lb.; 30-in., $26.50; specials, 3 cts.; Ohio Pipe Foundry, Columbus, O., 3 to 16-in. pipe and castings, $29 and 3¼ cts.; 30-in., $29.97 and 3¾ cts.; Addyston Pipe & Steel Co., Cincinnati, O., 3 to 16-in. pipe and castings, $29 and 2¾ cts.; 30 in., $28.50 and 2¾ cts.; Buffalo Cast-Iron Pipe Co., Buffalo, N. Y., 3 to 16 in. pipe and castings, $28.40 and 3 cts.; 30-in., $28.85 and 3¾ cts.; New Philadelphia Pipe Works, New Philadelphia, O., 3 to 16-in. pipe and castings, $27.10 and 3 cts. The contract was awarded to the Lake Shore Foundry.

Street Work.—The following proposals have been received by the City Commissioner, Baltimore, Md.: work on Holbrook St.: Wm. E. Anderson, grading, 18 cts. per cu. yd., curbing 40 cts. per lin. ft.; paving 6 cts. per sq. ft.; Patrick Keelty, 15, 38 and 5½ cts.; A. Schneider & Sons, 22, 40 and 6 cts.; Patrick Reddington, 17, 40 and 6 cts.; Owen Patterson, 26, 42 and 6 cts.; Jas. P. McGovern, 14½, 40 and 6 cts. Patterson Park Ave.: Patrick Keelty, grading 19 cts., curbing 39 cts., paving 5½ cts.; Bergman & Peddicore, 12, 40 and 5½ cts.; A. Schneider & Son, 27, 40 and 6¼ cts.; Patrick Reddington, 23, 40 and 6¼ cts.; Jas. P. McGovern, 18½, 40 and 5½ cts.; Owen Patterson, 27, 45 and 6¼ cts. Federal St.; Wm. E. Anderson, grading 18 cts., curbing 40 cts., paving 5½ cts.; Patrick Keelty, 14, 39 and 5¾ cts.; A. Schneider & Son, 22, 40 and 6 cts.; Patrick Reddington, 17, 40 and 6 cts.; J. P. McGovern, 14½, 40 and 6 cts.

Paving.—The following proposals for paving have been received by JOHN J. GRANVILLE, City Engineer East Saginaw, Mich.: Welles St.; Scanlan & Crowley, $1,301.14 if earth excavated to belong to contractor $1,278 40 if earth to belong to the city; John C. Davies, $1,259.50 and $1,229.20. Sixth St.; Scanlan & Crowley, $7,154.40, $7,154.40; John C. Davies, $6,942.35, $6,796.35. Maple St.; Scanlan & Crowley, $4,341.55, $4,341.55; John C. Davies, $4,198.05, $4,110.65. Contracts awarded to John C. Davies. Washington Ave.; Scanlan & Crowley, $5,789.29, $5,787.29; John C. Davies, $5,866.15, $5,848.02. Contract awarded to Scanlan & Crowley. The range of the bids averaged as follows: excavation, 19 to 25 cts. per cu. yd. if earth to belong to the contractor, 15 to 23 cts. if to belong to the city; curb, 60 to 65 cts. per ft.; cedar block paving, 84 to 86 cts. per yd.; curb timber, $14 to $16 per 1,000 ft. B. M.; cobble stone, 89 and 90 cts. per yd.; culvert covers, $1.75 to $2 each; tile drain, $2.25 to $2.50 per rod.

The Vulcan Iron Works, 86 North Clinton St., Chicago, Ill., have issued an illustrated pamphlet relating to pile driving machinery. There is a description, with cuts, of Wm. T. Casgrain's patent pile cap to prevent the splitting or brooming of the piles and to be used instead of the ordinary hoops: it is a cast-iron cap with tapered recesses above and below, the chamfered head of the pile fitting into the lower one and a wooden block into the upper one, the hammer striking this block. Points, bands, sheaves, hoisting engines, etc., are described and illustrated. Also swivel, floating, township and railroad car pile drivers. There are 5 pages devoted to the Vulcan-Nasmyth improved steam pile hammer, including a page of directions for operating the same. Prices are given for hammers, nippers' trips, toggles, etc.

The Bucyrus Foundry & Mfg. Co. has recently shipped the largest and most powerful steam shovel ever built in this country to the Lake Shore & Michigan Southern Ry. Co., to be used in digging shale rock at Ashtabula, O., on that road, which it is expected to do without blasting. This machine, which is one of two ordered by this road, has a daily capacity of 4,000 to 5,000 cu. yds. in ordinary material and will handle a three yard bucket. The company is also building a large and powerful dredge for the U. S. Government, and another for the Commissioners of the South Park, Chicago. The company has on hand a large number of orders for steam shovels, dredges, wreckers and other machinery, and the prospects for the year are very bright.

Water-Works.—*Findlay O.*—The Water-Works Board has awarded the contracts as follows: Addyston Pipe & Steel Co., Newport, Ky., pipe $25.80 per ton, $70,074.40 James J. Rumsey, Canton, O., pipe laying; 18 miles, $23,820.71. Bourbon Copper & Brass Works, Cincinnati, O., hydrants, $4,823.60. Eddy Valve Co., Waterford, N. Y., valves and boxes, $2,609.60. Gordon & Maxwell Mfg. Co., Hamilton, O., engines, pumps and boilers, $16,637. A list of the bids was given on page 170.

Falls City, Neb.—The contract has been awarded to S. K. Felton, of Omaha, Neb. The other bidders were, A. T. Prentis, Chicago; Heinaman & Howe, Falls City; Deane Steam Pump Co., Holyoke, Mass.; Gordon & Maxwell, Hamilton, O.; W. B. Schneider, Falls City; Eddy Valve Co., Waterford, N. Y.; Standard Supply Co., Kansas City, Mo.; Shickle, Harrison & Howard, St. Louis, Mo.; Geo. H. Morgan, Chicago.

Bridge Contracts.—*Selbyport, Md.*—The County Commissioners, Garret county, have awarded the contract for an iron bridge at this place to the Pittsburg Bridge Co., Pittsburg, Pa., at $5,500.

Decatur, Ala.—The Decatur Iron Bridge & Construction Co. has been awarded the contract for 4 iron bridges on the Chattanooga, Rome & Carrollton R. R. The cost will be about $35,000.

Atlanta, Ga.—The Georgia Central R. R. Co. has awarded the contract for the substructure of the Nelson St. bridge to Wm. McConnell & Son, of Atlanta, and for the superstructure to the Atlanta Bridge & Axle Co.

Minneapolis, Minn.—Kerrick & Watson, of Minneapolis, have been awarded the contract for all bridging on the extension of the St. Paul, Minneapolis & Manitoba Ry. from West Superior to Hinckley.

St. Paul, Minn.—The following proposals have been received for the Lyndale Ave. bridge over the St. Paul, Minneapolis & Manitoba and Minneapolis & St. Louis railroads; there will be two spans, 168 and 105 ft., long: *Substructure*: Minnesota Stone Co., $6,185.65; Douglas & Co., $6,504.22; Geo. McMullen, $6,596.10; Baxter & Sons, $6,708.07; M. Daley, $6,868.68; Ring & Tobin, $7,870.34.—*Superstructure*: Wrought Iron Bridge Co., Canton, O., $19,518, $20,635; King Iron Bridge & Mfg. Co., Cleveland, O., $21,393; Smith Bridge Co., Toledo, O., $21,000; Jones Bridge Co., Chicago, Ill., $21,546 23; Kansas City Bridge Co., $23,750; Scheffler Bridge Co., Milwaukee, Wis., $23,970.24; A. G. Bayne & Co., Minneapolis, Minn., $24,056. The estimates of Engineer Coppelen, were $6,595.30 and $22,926.

Sewers.—*Rochester, N. Y.*—The Executive Board has awarded contracts as follows: Schanck Ave., F. C. Lauer's Sons, $18,865, (estimate, $21,500); Fourth Ave. pipe sewer, John Mauder, $1,900, (estimate, $2,350); Bronson Ave., pipe sewer, Wm. Fuller, $2,200.25, (estimate, $2,450).

Allegheny, Pa.—The contract for a lateral sewer on Bidwell St. has been awarded by JAMES BROWN, Comptroller, to Scanlon & Haggerty, at $340.

Railroad Contracts.—*Chattanooga, Rome & Columbus R. R.*—John Harrison, of Rome, Ga., has a 20 miles contract.

Louisville Southern R. R.—Joseph Coyne has the contract for switches, side tracks and ditching between Louisville, Ky., and Brunerstown, 12 miles.

Atlanta & Florida R. R.—August Shaw, of Atlanta, Ga., has the contract for 50 miles of tracklaying, from the Georgia Midland R. R. to Fort Valley, Ga.

Macon & Covington R. R.—Hampton & Bradeen, of Athens, Ga., have a contract for grading.

Carolina, Knoxville & Western R. R.—The contract for grading, trestling, bridging and masonry on the So. Carolina division, from Greenville, S. C., to the North Carolina State line, about 40 miles, has been awarded to Tanner & Co., of Cowpens, S. C. Their headquarters will be at Greenville, S. C.

Fort Worth Western R. R.—Eugene Roche, of Fort Worth, has the contract for the construction of the first 30 miles of the road.

Anaheim, Olinda & Pomona R. R.—Gleason & Graham, of Anaheim, Cal., have the contract for grading this narrow gauge road between Anaheim and Carlton.

St. Paul, Minneapolis & Manitoba.—Foley Bros., of St. Cloud, Minn., have the contract for the construction of the Hinckley & Duluth extension.

Sewers.—The following proposals for sewers have been received by the Board of Public Works, Beatrice, Neb.: W. H. Duffett, Leavenworth, Kan., $27,928.45; Shannon & Kilpatrick Bros., Beatrice, $29,680; John Layne, Lincoln, Neb., $29,723.36; E. J. Hanlon, Sioux City, Ia., $29,790.50; F. S. Blodgett, Milwaukee, Wis., $32,239. The contract was awarded to W. H. Duffett, who has contracted with the Beatrice Sewer Pipe Co. for the necessary sewer pipe. Work is to be completed by July 10.

Mr. Duffett writes us, "being a subscriber to ENGINEERING NEWS, from which I received the information of the Lincoln, Neb., sewerage and obtained the contract, also now the Beatrice, Neb., contract." This note from a man practically interested in getting news of contracts open is a pretty good proof of the value to contractors of our "Construction News" in particular, and of ENGINEERING NEWS in general. ED.

Paving Stones and Curb Stones.—The following proposals have been received by I. H. HARRIS, Superintendent of Streets, Brockton, Mass: Webb & Batchelder, Worcester, Mass., $33 per 1,000 for paving stones, 50 cts. per ft. for curb stones; Thos. F. Walsh, West Quincy, Mass., $37, 52 cts.; Paving stones, Thos. McCarty, North Acton, Mass., $26.50 per 1,000; S. & R. J. Lombard, Charlestown, Mass., $26; Charles Wilson, Quincy, Mass., $1.10 per sq. yd.; McDonnell & Sons, Quincy, Mass., $35 per 1,000; Carkin Bros., North Chelmsford, Mass., No. 1 $55, No. 2 $45; Charles A. Bailey, Suncook, N. H., $25; Curbstones, A. A. Libby & Co., 28 School St., Boston, 60 cts. per ft.; Noah Prescott, Westford, Mass., 48 cts.; Nelson Messer, Brockton, 48 cts.; Severin Martell, W. Quincy, Mass., 50 cts. per ft.; James A. Colson, Charlestown, Mass., 49 cts. The contract for paving was awarded to Chas. Wilson, Quincy, Mass., at $1.10 per sq. yd. The contract for curbing was awarded to Nelson Messer, of Brockton, at 48 cts. per lin. ft.

Bulkhead.—The contract for a rip-rapand pile bulkhead in Morris canal basin for the Lehigh Valley R. R. Co. improvements at Jersey City, N. J., has been given to D. S. Cofrode of Jersey City. WALTER G. BERG is Principal Assistant Engineer.

Pipe and Castings.—The Executive Committee of the Aqueduct Board, Newark, N. J., has received the following proposals for 20-in. pipe and castings: John Fox, $29.50 per ton for pipe, 2¼ cts. per lb. for castings; R. D. Wood & Co., Philadelphia, $28.45, 2.85 cts; Warren Foundry & Machine Co., New York, $27.75, 2¾ cts. The contract was awarded to the Warren Foundry & Machine Co. Proposals will be asked for 20,000 ft. of 6-in. mains and for pipe for the 12th Ward extension.

The New York Electric Light & Water Supply Co., of Buffalo, N. Y., has been incorporated by H. M. COOPER, J. R. SILLIMAN, GEO. H. PIERCE, C. C. PICKERING and W. BOWEN MOORE. Capital stock, $50,000. The company proposes to contract for establishing electric light and water-works. Contracts are said to have been secured in Alabama and Florida.

Street Railways.—T. Wm. Harris & Co., New York, have the contract for the construction of a street railway at Syracuse, N. Y.— The electric railway built by them at Richmond, Va., is now in successful operation.

Sewers.—The City Council, Quincy, Mass., has passed an ordinance to lay about 19 miles of sewers, from 12 ins. to 60 ins. Proposals will be advertised for shortly. Address E. H. OSBORN.

Machine Tools.—The following proposals have been received at the Navy Department for furnishing machine tools for the ordnance gun shops at the Navy Yard, Washington, D. C.: Group 1, for 6 lathes for 16-in. B. L. R.: Niles Tool Works, Hamilton, O., $406,800; Pond Machine Tool Co., Plainfield, N. J., $414,200; Bement, Miles & Co., Philadelphia, Pa., $419,000; Southwark Foundry & Machine Co., Philadelphia; $436,968.—— Group 2, for 3 lathes for 16-in. B. L. R. jackets: Bement, Miles & Co., $117,500; Pond Machine Tool Co., $120,500; Niles Tool Works, $123,000; Southwark Foundry & Machine Co., $136,383.—— Group 3, for 7 lathes for 16-in. B. L. R. hoops: Binsse & Hauschild, Harrison, N. J., $160,000; Southwark Foundry & Machine Co., $163,758; Pond Machine Tool Co., $177,100, $211,300; Niles Tool Works, $180,000, $215,000; Bement Miles & Co., $189,000, $204,000.

Water Works Supplies.—At Allegheny, Pa., the Water Works Department has awarded the following contracts for work for the present year; National Foundry & Pipe Works, Scottdale, Pa., 4-in. pipe, $28.45; 6 and 8-in., $27.45; 10, 12, 16, 20, 24, 30 and 36-in., $26.45; branches and sleeves, 2½ cts. per lb.——J. R. Hutchinson, 4-in. stop gates, $10; 6-in., $14; 8-in., $22; 10-in., $33; 12-in., $46., 16-in., $68; 20-in., $120; 24-in., $210; 30 in., $350; 36 in., $550; fire plugs, $26 each.——Bailey, Farrell & Co., pig lead, $5.50 per 100 lbs.——McKay Mfg. Co., ¾-in. brass ferrules, $5.75 per dozen; ⅝-in., $6.50; ¾ in., $8.50; ⅞-in., $9.25; 1-in., $9.90.——Samuel Hastings, stop-gate boxes, $4.50 each; fire plug boxes, $2.50 each; washout boxes, 40 cts. each.——Thos. Carlin's Sons, miscellaneous castings, $1.62 per 100 lbs.——Wm. H. Megraw: hauling, 30 cts. per load; 2 horse wagon, and 2 horse timber wheels, $4.50 per day.

Water Pipe, Sewers, Etc.—The Department of Public Works, Lake View, Ill., opened proposals March 6 for 485 tons of cast-iron water pipe, valves and special castings; 9 bids were received, the lowest bid was from Rhoads & Ramsey, of Chicago, 4-in., $28 per ton; 6 in., $27.45; 8-in., $27.85. The lowest bid for valves was from the Crane Bros. Mfg. Co.— Plans and specifications have been prepared by the engineering department, for curbing and paving about 10 miles of streets during the present season; 10½ miles of sewers will be put in, and about 6 miles of water mains laid. J. W. ALVORD is Chief Engineer; EDGAR SANDERS, Commissioner of Public Works.

Trestle and Bridge.—Duncan A. Gillies has been awarded the contract for the erection of 1,800 ft. of trestle, with an iron bridge 160 ft. span, near Baltimore, Md., on the South Baltimore extension of the Baltimore & Ohio R. R. The work is to be completed in May.

Stone.—The following was the only proposal for furnishing stone for lock at Beattyville, Ky., opened March 3 by Major Amos Stickney, U. S. Engineer Office, Louisville, Ky.: Wendell R. Curtis, of Frankfort, Ky., 1,800 cu. yds. of dressed face, $16.93; 1,500 cu. yds. of quarry face, $14.45; 1,301 cu. yds. of squared stone, $11.93.

The Kalamazoo Railroad Velocipede Co., of Kalamazoo, Mich., has secured the services, as traveling salesman, of JAMES A. SANGSTON, formerly southern passenger agent of the Illinois Central R. R.

Tank.—The following proposals for a wrought iron tank at Breed's Island have been received by the Water Board, Boston, Mass.; W. E. SWAN, Clerk: Geo. Miles, Boston, $2,620; E. Hodge & Co., Boston, $2,496; E. Kendall & Sons, Cambridgeport, $2,625; Whittier Machine Co., Boston, $2,696; H. S. Robinson, Boston, $2,779; Cunningham Iron Works Co., Boston, $2,800; Atlantic Works, Boston, $2,975; J. Russell & Sons, Boston, $3,190; Scannell & Wholey, Lowell, $3,213; Tippett & Wood, Phillipsburgh, N. J., $3,275; King Iron Bridge & Mfg. Co., Cleveland, O., $3,728; Riter & Conley, Pittsburg, Pa., $3,885; Ryan & McDonald, Waterloo, N. Y., $4,350. The contract was awarded to George Miles.

Proposals Open.

Submerged Pipe.—Furnishing and laying 16-in. cast-iron pipe across the Chattahoochee river between Columbus, Ga., and Lovily, Ala., about 850 ft. B. F. ARCHER, President, Columbus Water-Works Co., Camden, N. J.

Pipe, Castings, Etc.—Cast-iron water-pipe, 600 tons of 6 in.; 70 gates, 25 hydrants; also specials, taps, lead and supplies for laying water and sewer pipes. S. M. GRAY, City Engineer, Providence R. I.

Paving.—Five streets; aggregate amount about $30,000. JOHN J. GRANVILLE, City Engineer, East Saginaw, Mich.

Iron Bridge.—Over Kalamazoo river at East Ave.; 2 spans of 125 ft.; roadway 24 ft.; 2 sidewalks 5½ ft.; skew about 45°; load 100 lbs. per sq. ft. of floor. Specifications at the City Engineer's office. CHAUNCEY STRONG, City Clerk, Kalamazoo, Mich. March 20.

Asphalt Paving, Etc.—About 8,630 sq. yds. Trinidad asphalt pavement, 2,250 sq. yds. granite block pavement, 2,500 lin. ft. curbing. ROBT. HOOKE, Superintendent, Board of Public Works, Chattanooga, Tenn., March 19.

Wood Paving.—About 1,850 lin. ft. of white or red cedar block paving on plank or concrete foundation; separate bids for both forms. Specifications at the City Engineer's office. F. A. BURKE, City Clerk, Council Bluffs, Ia., March 20.

Foundation Walls.—Stone walls for foundations of Colorado State Capitol Building. Plans and specifications on file. THE BOARD OF CAPITOL MANAGERS, Denver, Col. March 20.

Fencing, Filling and Draining.—Block bounded by 154th St., 155th St. and 8th Ave. THE COMMISSIONER OF PUBLIC WORKS, 31 Chambers St., New York City. March 21.

Sewers and Street Work.—Sewers: regulating, grading, curbing and flagging. THE COMMISSIONER OF PUBLIC WORKS, 31 Chambers St., New York City. March 21.

Lumber.—White oak, about 40,000 ft. B. M. of 2½ in. plank 9 and 10 ft. long and 8 to 14-in. wide, 10,000 ft. B. M. of 1¼ in. sheeting 8, 9 and 10 ft. long and 5 to 9-in. wide, 50 joists 3-in. by 12 in. by 14 ft., 30 joists 4½-in. by 12-in. by 30 ft. Pine, about 30,000 ft. B. M. of 1 and 2-in lumber 12 in. wide, 2 by 3 in. joists 12 in. wide, 2 by 4-in scantling; all 12 to 18 ft. long. W. P. RICE, City Engineer, Cleveland, O. March 22.

Paving Blocks and Stone.—Stony brook improvement. Paving blocks 8,000, rubble stone 650 tons, dimension stone, 210 cu. yds. SETH PERKINS, Superintendent of Sewers, Boston, Mass. March 22.

Tunnel.—For sewer in Ruggles Ave., 1 600 ft. H. A. BENTLEY, City Engineer. WM. H. LAWTON, JR., Street Commissioner, Newport, R. I. March 23.

Asphalt Pavement.—About 3,800 sq. yds. on Thames St.: sheet or block asphalt. H. A. BENTLEY, City Engineer. WM. H. LAWTON, Jr., Street Commissioner, Newport, R. I. March 23.

Street Lighting. — Furnishing gas or other illuminating material; also furnishing and operating electric lamps for streets, parks, etc., for 1 year from May 1. THE COMMISSIONER OF PUBLIC WORKS, 31 Chambers St., New York City, March 26.

Court House.—Extension of Montreal court house. A. LEVEQUE, architect, 12 Place d'Armes, Montreal. ERNEST GAGNON, Secretary, Department of Agriculture and Public Works, Quebec, Canada. March 27.

Vertical Wall.—Rebuilding about 290 ft. of vertical wall in cement, on the Glens Falls feeder; bailing and draining, 275 cu. yds. earth excavation, 150 cu. yds. embankment, 175 cu. yds. rock excavation without blasting, 50 cu. yds. rock excavation with blasting, 325 cu. yds. of wall in cement, including coping, 70 cu. yds concrete. JAMES SHANAHAN, Superintendent of Public Works, Albany, N. Y. March 27.

Sewers and Street Work.—Pipe sewers, manholes and flush tanks. Asphalt, cedar block, granite block and sandstone pavement. Grading, etc. Plans and specifications at the office of JOHN J. TETON, City Clerk, G. A. WILCOX, Chairman, Board of Public Works, Nebraska City, Neb. March 27.

Armory.—Masonry, iron work, carpenter work, plumbing and gas fitting, steam heating and ventilating. THE ARMORY BOARD, *Staats Zietung* Building, New York City. March 29.

Pumping Engine and Boilers.—Pumping engine of 2,000,000 gall. daily capacity, and 1 boiler, at high service pumping station; 2 boilers at low service station. Jos. A. LOCKWOOD, Superintendent of Water-Works, Yonkers, N. Y. March 29.

Court House.—Furnishing and laying about 9,000,000 brick, setting about 140,000 cu. ft. dressed granite, furnishing and setting iron framing for roof. THE COMMISSIONERS FOR SUFFOLK COUNTY COURT HOUSE, Boston, Mass. March 29.

Water-Works.—Materials and labor for the construction of water-works for the village of Avon. ORANGE SACKETT, Town Clerk and Water Commissioner, Avon, N. Y. March 29.

Sewers.—Central division of the general system of sewers. Plans and specifications with W. G. WILLIAMSON, City Engineer. W. S. REESE, Mayor, Montgomery, Ala. April 2.

Sewers.—System of sewers. GEO. C. POWER, Engineer, J. F. NEWRY, Town Clerk, San Buenaventura, Cal. April 2.

Hoisting Engines.—Three hoisting engines for work on the Muskingum river improvement. Lieut. Col. WM. E. MERRILL, U. S. Engineer Office, Zanesville, O. April 2.

Cement.—Natural cement 1,000 barrels, Portland cement 500 barrels; for the Muskingum river improvement. Lieut. Col. WM. E. MERRILL, U. S. Engineer Office, Zanesville, O. April 2.

Sewers.—Brick, vitrified pipe and cast-iron pipe, manholes, etc. F. FLOYD WELD, City Engineer, Waterbury, Conn. April 4.

Iron Wire.—About 20 miles of B. W. G, galvanized iron wire No. 14. Gen A. W. GREELY, Chief Signal Officer, Signal Office, War Department, Washington, D.C April 7.

Water-Works.—For Callao, Peru. THE PERUVIAN CONSULATE, New York City. June 26.

WATER.

The Villa Verona Land & Water Co. has been incorporated by L. L. BAKER and R. M. HAMILTON, of San Francisco: J. C. GRAY, of Oroville, and others. Capital stock, $400,000.

Drainage of the Passaic Swamps.—It is proposed to drain the extensive wet lands in Morris and Passaic counties, about 1,400 acres of which are now useless, by lowering Beatty's dam at Little Falls, and enlarging the channel of the river. Legislative action is to be petitioned for.

Callao, Peru.—Proposals have been called for by the Callao municipality for the supply of fresh water required by that city, and also for the improvement of the drainage and sewerage systems. For particulars apply at the Peruvian consulate, New York City. Proposals will be received till June 26.

The Viviende Water Co. has been organized at Riverside, Cal., to lay a pipe line for the irrigation of 2,000 acres above the Gage canal. Water will be taken from Lytle creek and work will be completed by October. President, Mr. FUDICER; Secretary, Mr. MERIAM.

Trenton, N. J.—The idea of supplying the city with water for domestic purposes originated with Stephen Scales in 1801 and about 4 years later, under an act to incorporate the "Proprietors of the Trenton Water-Works" a supply was obtained from springs north of Pennington avenue and conveyed through wooden pipes. About 34 years afterward iron pipes were laid and a turbine water-wheel, a 10-in. pump and a reservoir were established to furnish a supply from the Delaware river. In 1853 the works were put in operation: the engine had a daily capacity of 600,000 galls., and the reservoir had a capacity of 6,000,000 galls. In 1855 an additional storage reservoir was built, and in 1858 the 2 reservoirs were filled for the first time. In 1864 there was a scarcity of water and a portable steam engine was put in to drive the pump, the water-wheel being stopped by high water. The old springs were then used for the last time. The quality of the present supply is excellent. Another reservoir is contemplated for the accommodation of the 7th Ward. There are about 40 miles of 2-in. to 20-in. pipe. The present pumping plant, which has a daily capacity of 6,000,000 galls., was furnished by H. R. Worthington, of New York.

Madison, Wis.—The lake connection of the water-works has been abandoned; the analysis did not result as was expected, and the matter was brought before the public through the press, where it met with decided opposition. The Water Commissioners have decided to place meters to prevent the waste, and by that means save the water.

Portland, Me.—The Portland Water Co. is advertising in London, England, the issue of $800,000 consolidated mortgage bonds. The company was incorporated in 1866, and has been in operation since 1870; common stock, $1,000,000; authorized bonded debt, $1,500,000. Water is supplied to Portland, Deering and Westbrook, and there is a prospect of the pipe lines being extended to Gorham, Windham and Cape Elizabeth. The total length of main and distribution pipes laid to date is 96 miles 1005 ft.

Syracuse, N. Y.—The Syracuse Water Co. has submitted a proposition to the city in which it offers to furnish a daily supply of 20,000,000 galls. from gang wells at Onondaga Valley, to construct and furnish a system which will furnish the highlands with a full supply, to extend the present system by about 30 miles of pipe, and to begin work immediately upon favorable action being taken by the city; the company only requires an exclusive right for 10 years. Analyses of the work, etc., accompanied the proposition.——Mr. WM. A. SWEET's bill for a supply from the Salmon river has been introduced at Albany.

The National Water Purifying Co., 145 Broadway, New York City, has had its system of water purification adopted by the following cities: Exeter, N. H.; Massillon, O.; Chattanooga, Tenn.; Kokomo, Ind.; Champaign, Ill.; Lawrence, Kan.; Sioux Falls, Dak., and Winnipeg, Man., Hackensack, N. J., and Hoboken, N. J., are also using the company's aerating plants for mains and reservoirs. The National filter, used in connection with the system of aeration, precipitation and filtration, was only placed upon the market in March 1887, and the extent to which it has been already adopted is very satisfactory. In addition to the cities above named a large number of manufactories have these filters in use. The company, whose advertisement will be found in our advertising pages, issues a circular giving information and testimonials.

Water Works.—*Connecticut.*—Stonington. The Mystic Valley Water Co. has made a proposition to establish a water supply. There will be a reservoir with a capacity of 2,000,000 galls.; also 42 hydrants.

Massachusetts.—Braintree. The works which are being built by J. Cavanagh & Son, of Boston, will be completed this spring. There will be 12 miles of pipe, 100 hydrants, 100 gates, stand-pipe 100 ft. high and pumping engine with a daily capacity of 15,000,000 galls.

New York.—Brooklyn. The old Hudson River Valley Aqueduct bill has been introduced at Albany by Senator PIERCE. This bill provides for a water supply from the Adirondack region or Hudson river valley. ——Clyde. A Buffalo company has made a proposition to put in water-works; the city to pay $1,750 per annum for 40 hydrants.——Gloversville. The citizens' committee has resolved that an additional water supply is needed and that the supply should be obtained from Jackson creek. The cost is estimated at $96,718.27, and the supply would be sufficient to supply 50 galls. per capita per day for a population of 43,000. Address the Water Commissioners.——Lansingburg. The bill before the legislature for bonding the town for additional water supply is to be amended to provide that the money be used for an additional reservoir and that the taxpayers be allowed to vote on issuing the bonds before they are sold.——Springville. A second test of the new works was made March 1, and proved satisfactory.

New Jersey.—Asbury Park. The Consumers Water Co. has been organized, and has received permission to lay its pipes in the streets. The water will be supplied from an artesian well.

Maryland.—Cambridge. The Town Commissioners are to be authorized to levy a water tax of not less than 5 nor more than 8 cts. per $100 of the assessable property of the town for the purpose of establishing water-works.——Towsontown. At a meeting of the Towsontown Water Co., Dr. J. PIPER, president, on March 5, D. E. Miller, the contractor for sinking the artesian well, stated that the test he made showed that the well would yield 25 galls. of water per minute. The pump used was not capable of drawing over that amount per minute, and he was satisfied there was a much larger flow. The board ordered that a test should be made with a pump having a capacity of 50 galls. per minute. The amount already obtained (1,500 galls. per hour) would be sufficient to supply the town for years, but it was thought more satisfactory to obtain the full yield of the well. Mr. MCCLEAN, the engineer, reported that it would be necessary to construct a reservoir holding 36,000 galls., and the board resolved to go on with the work of erecting the reservoir, and laying the pipes as soon as the second test is made.

Ohio.—Cincinnati. The following are the experts to consider the question of the city's water supply: CHARLES HERMANY, of Louisville; HENRY FLAD, of St. Louis; C. B. BRUSH, of Hoboken, N. J.; DEWITT C. CREGIER, of Chicago; and A. FTELEY, of New York. The fees are said to be $100 per day.——Conneaut. The Conneaut Water-Works Co. has been incorporated at Columbus, O., with a capital stock of $100,000.

West Virginia.—Guyandotte. The Guayandotte Water-Works Co. has been organized by T. E. STOUT, of Huntington, W. Va.; W. S. KUHN, of McKeesport, Pa., and others. Capital stock, $100,000.

Virginia.—Portsmouth. The Portsmouth & Suffolk Water Co. is pushing its works and will have them completed in a few months. M. COLEMAN is Superintendent.——Manchester. Water-works are to be built, it is said, by Capt. White, of New York.

Georgia.—Dalton. The water-works will probably be undertaken soon. Address the Water-Works Committee.

Kentucky.—Pineville.—Water-works are to be established. Address the Pineville Land, Coal & Iron Co.

Tennessee.—Murfreesboro. M. Collins, of the Murfreesboro gas-works, has submitted plans and specifications for a system of water-works to the Board of Aldermen.

Alabama.—Anniston. The Anniston Land Co. will put in additional pumping plant, with a daily capacity of 1,500,000 galls. at the water-works.——Mobile. The suit between the Mobile Water-Works Co. (Stein's company) and the Bienville Water-Works Co., over an exclusive right to supply the city with water claimed by the former company, has been decided by the Supreme Court adversely to the plaintiff company on the ground that Stein by contract with the city of Mobile in 1840 had no exclusive right to supply the city with water, being limited to Three-Mile creek. That question being determined, all the rest are immaterial. The Bienville Water Co. obtains its supply from Eight-Mile creek.

Illinois.—Joliet. The 7 years litigation between the city and the Joliet Water-Works Co. has been terminated on an agreement to arbitrate upon a valuation of the plant, upon which the city of Joliet is to purchase. The water-works company has beaten the city in every court, from the lowest to the highest, in the United States. The city is bound to purchase the works, and the company is bound to sell at the price fixed by the board of arbitrators, which is composed of A. GOTTLEIB, of Chicago, President of the Western Association of Civil Engineers, for the company; L. B. JACKSON, Chief Engineer of the Elgin, Joliet & Eastern Railway Co., for the city, and THOMAS J. WHITMAN, of St. Louis, chosen by the first two arbitrators. They will meet in Chicago, April 19, and hold their sessions, hearing both sides, till they finally agree upon a valuation.

Wisconsin.—Superior. The Superior Water-Works Co. will resume work in May, President, R. J. WEMYSS, of West Superior.

Arkansas.—Hot Springs. The Hot Springs Water-Works Co. will enlarge its plant.——Rogers. A company to establish water-works and lime works has been organized, with a capital stock of $12,000. Address J. A. C. BLACKBURN, Key, Ark.——Bentonville. A proposition to build water-works has been made by parties from Kansas City, Mo.

Nebraska.—Edgar. An election on the proposition to bond the city for water-works will be held March 23. Plans and specifications have been prepared by A. A. RICHARDSON, of Lincoln.

Oregon.—Portland. A 14-in. pipe is to be laid to connect the old pumping works with the Lincoln St. reservoir.

Washington Territory.—Walluiah. A system of water-works is contemplated.

Texas.—Waco. The people have condemned the cistern system for fire protection, mentioned last week, and it is recommended that if satisfactory arrangements cannot be made with the Waco Water Co., the Council issue bonds and build works for the city.

Canada.—Chatham, Ont. The Board of Health has the question of water-works under consideration, and has received several suggestions. Artesian wells are recommended.

Electric Light and Gas.—*West Springfield, Mass.*—The Agawam Gas Co. has been incorporated. President, J. R. SMITH. Capital stock, $50,000.

Orange, Mass.—The electric light is in operation. The Thomson-Houston and the Westinghouse systems are used.

Pawtucket, R. I.—The Pawtucket Gas Co. has bought out the Pawtucket Electric Lighting Co.

Hudson, N. Y.—The Hudson Electric Light & Power Co. has been incorporated by A. W. RICE, T. A. BOYNTON, and others. Capital stock, $90,000.

Hagerstown, Md.—The city has granted an exclusive franchise for an incandescent electric light plant to the successful bidder for the street arc lights.

Frederick, Md.—An electric plant will probably be established.

Annapolis, Md.—The Annapolis Electric Light Co. has been incorporated by Dr. G. WELLS, ELIHU SEALEY, and others, to supply electric light and gas. Capital stock $100,000. The city pays $2.25 per 1,000 ft. for gas.

Hamilton, O.—An ordinance has been passed providing for the issue of $150,000 bonds for building new gas works or purchasing the old ones.

Fort Wayne, Ind.—The City Council has contracted with the Fort Wayne Jenney Electric Light Co. to light the city for 3 years at $135 per light per annum.

Lake, Ill.—The Peoples Electric Light & Motor Power Co. proposes to put in an electric light plant.

Jackson, Tenn.—The Citizens Gas Light Co. has made a proposition to modify the present contract for 25 electric lights on dark nights, for which the city pays $2,000 per annum. The proposition is for 30 lights, every night, at $3,000, and additional lights $100 each.

Telluride, Col.—The Telluride Electric Light & Power Co. has been incorporated by JAMES F. MATHEWS, J. B. INGRAM and H. H. CORBIN. Capital stock, $10,000.

Sherman, Tex.—The city has purchased the electric light plant, paying $6,000 for the dynamo.

Galveston, Tex.—The Brush Electric Light & Power Co. has been consolidated with the Galveston Gas Co.

Corsicana, Tex.—The Corsicana Gas Light Co. has been organized by B. T. BARRY, SAMUEL R. TROST and J. R. MILLER. Capital stock, $50,000.

Cleburne, Tex.—The Cleburne Gas Light Co. has been organized by B. T. BARRY, S. A. GREENWALL and S. C. PADELFORD. Capital stock, $35,000.

Covington Reservoir.—GEO. BOUSCAREN, of Cincinnati, O., Consulting Engineer for the Trustees of the Covington reservoir, at Covington, Ky., has made his report for 1887. The preliminary surveys for the site were commenced Jan. 5, 1887. The reservoir is formed by damming a branch of Three-Mile creek: the lower, or distributing basin, will hold about 27,000,000 galls.; the two upper, or subsiding basins, will hold about 26,500,000 galls. and 31,000,000 galls. The probable daily consumption is estimated at 3,000,000 galls. The dams will be 15 ft. wide on top, inner slope 3 to 1, outer slope 1¼ to 1. The pump house is located on the south shore of the Ohio: it will have stone foundations, brick walls and wooden roof; water will be taken to the pump well through an aqueduct 158 ft. long, 4 ft. inside diameter, partly in tunnel; the house, well and aqueduct are calculated to accomodate a pumping plant of 20,000,000 galls. daily capacity. The pumping plant to be put in will be of 10,000,000 galls. capacity; consisting of 2 vertical engines of 5,000,000 galls. capacity each, each operating 4 pumps. The contractors are as follows: Addyston Steel & Pipe Co., Newport, Ky., pipe and castings; McRae & Lally, Detroit, Mich., pipe laying; Peter, Scully & Crane, Cincinnati, O., reservoir, (transferred to S. Casparis & Co.); C. J. Limrick, Newport, Ky., pump house, well and aqueduct; Holly Mfg. Co., Lockport, N. Y., pumping engines; Eddy Valve Co., Waterford, N. Y., valves. The details of prices are given in the report. The total estimated cost is $979,092.25, of which $810,000.05 is for work under contract, and $10,002 for work not yet contracted for. A. PETRY is Resident Engineer.

The Southern New Mexico Canal.—The survey of the canal contemplated in southern New Mexico is about completed. The report states that it will be necessary to commence at a point near Los Lunas, on the Rio Grande, and that the cost of construction to San Antonio, N. M., will be about $820,000 per mile, as the ground is very rough. From the latter point about 90 miles over the Jornada de Muerto (journey of death) the work will be easy, and the cost about $17,000 a mile, with the exception of a tunnel a mile and a half long, which is estimated to cost about $130,000. The canal is surveyed for 130 miles and the total cost foots up $4,970,000. If this canal and reservoir scheme be put through it will bring under cultivation over 3,000,000 acres of now arid land. The originator of the scheme is Gen. J. B. BOWMAN.—St. Louis *Globe Democrat*.

Drainage in Illinois.—It is reported from Tolono, Ill., that the drainage districts in some parts of Illinois are proving in some instances a woeful burden to the farmers whom they were ostensibly organized to benefit. The assessments in some cases have grown so formidable that capitalists decline to lend money on the farms or to extend the time for payment of loans already made, as has always been the custom on request. Many poor farmers are thus compelled to sacrifice their property in order to save a little something from the impending wreck. In a few cases the Commissioners have bought the lands thus depreciated in value and then changed the course of the proposed ditch so as to relieve the property of the assessments originally levied against it. The farmers are in open rebellion against the many abuses to which they are subjected under the present drainage law, and will listen to nothing less than its absolute repeal or radical amendment. They are forcing the issue, and every candidate for the Legislature from this part of the State will have to define his position on this question before the campaign is over.—St. Louis *Globe Democrat*.

Candelaria, Nev.—The Candelaria Water-Works & Milling Co. is advertising in London, England, for applications for $350,000 6% first mortgage bonds. The company was formed in January, 1885, to acquire the water-works at Candelaria for the purpose of supplying the town and suburbs, the railroad and the mines; the present issue of bonds is to provide funds for completing the reservoirs and pipe lines, and building a short tramway. E. SKILTON is Secretary.

Brockville, Ont.—The outlet pipe of the new system of sewerage was successfully laid in the bed of the St. Lawrence on March 8. The pipe, 16 ins. in diameter, was all connected up and was hung to a timber frame by ropes. A channel was cut in the ice and at a given signal most of the ropes were cut; the weight broke the rest, and the pipe dropped into 45 ft. of water. The contractor was John F. Ward, of Jersey City, N. J. WILLIS CHIPMAN, City Engineer, was the engineer of the work.

Eufaula, Ala.—The water-works were tested March 5, with satisfactory results. There are 2,722 ft. of 8 in. cast-iron force main, 28,789 ft. of 4 to 10-in. cast-iron and wrought-iron cement lined distribution pipe, total 6.26 miles of pipe, 50 double nozzle fire hydrants and 36 gates. The stand-pipe is situated between the pumping station and the town, it is 26 ft. diameter and 70 ft. high, with a capacity of 278,600 galls.; the top is 143 ft. above the level of the business part of the city. There are two Davidson single plunger pumps, 10 × 20 in. cylinders, 10-in. plungers, aggregate daily capacity 2,000,000 galls.; the engines can be worked condensing or non-condensing. There are 2 boilers of 90 H. P. each, 16 ft. long, 5 ft. diameter, 46 4-in. tubes. The supply is drawn from dams on Shorter Spring branch and Little Chewella creek, the aggregate daily flow of which streams in dry weather is about 1,000,000 galls. The water passes through a filter chamber 20 ft. square, passing up through about 2 ft. of gravel and sand, and flows into a storage reservoir 159 ft. by 64 ft. and 17 ft. deep, the overflow is at 11 ft. at which depth the capacity is 570,000 galls.; thence it flows through a 10-in. pipe to the pump well. The works were built by Howland & Ellis. The engineer in charge was GEO. A. ELLIS; assistant, P. M. SLOCUM. The following are the officers of the water company: President, S. H. DENT; Secretary and Treasurer, E. B. YOUNG; General Manager, A. H. HOWLAND; Superintendent, R. H. WALKER. The contract called for 4 streams 75 ft. high or 120 ft. long in a horizontal direction, and these figures were exceeded at the test. The stand-pipe will maintain a pressure for these streams for half an hour without pumping.

Special Reports of Water-Works Construction.

The fourth yearly edition of the *Statistical Tables of American Water-Works* will be published as the ENGINEERING NEWS' MANUAL OF AMERICAN WATER-WORKS, and the change of name will be accompanied by such an enlargement of the scope of the work and such improvements in its completeness and correctness, as will make the volume *indispensable* to every manufacturer, engineer and contractor in any way interested in Water-Works construction and maintenance, and of great value to Water-Works superintendents and projectors of new works

We are now receiving reports from all parts of the country for use in compiling this book, and abstract the news of immediate importance below. We trust our readers will kindly aid us in making the Manual of American Water-Works as complete as we desire, by notifying us of any new works under construction or projected, which they do not see mentioned in our columns. Blanks for reports of existing works or works newly projected will be sent on request.

MILTON, Ont., March 9, 1888.

EDITOR ENGINEERING NEWS:—The reservoir for our water-works is completed, and it is proposed to finish the system by Aug. 1, 1888. The works were designed and are being superintended by Jas. A. Bell of St. Thomas, Ont. The contract for the whole system was let to McQuillan & Co., of Toronto, Ont. The supply is from springs by gravity, to a reservoir of 120,000 gallons capacity. The works will cost $18,400. Present population, 1,400. ALF. G. NEEDHAM, *Town Clerk.*

RICHMOND, Va., March 8, 1888.

EDITOR ENGINEERING NEWS:—Enclosed please find form sent me, filled out as requested. We have two pumping stations situated above the city on the James river, about two miles apart. The lower station contains the old pumps which were erected in 1830, and added to at different times, the last addition was in 1873, and consisted of a turbine wheel with pumps of 3,000,000 galls. capacity in 24 hours. The other water wheels at the lower station are old-fashioned "breast wheels," the pumping capacity of this station is 6,000,000 galls. in 24 hours. The pumps discharge into Marshall reservoir which supplies our lower service. The new pump house, or upper station, was erected in 1882: the wheels and pumps were designed by Prof. CHAS. SMITH of St. Louis, Mo., the wheel is known as the "Partial Turbine," and is run under a 20 ft. head of water; the pumps are single acting and vertical with a capacity of 12,000,000 galls. in 24 hours. At the upper station there is also a Worthington steam pump of 6,000,000 galls. capacity which is used rarely, and is kept as an auxiliary pump in the event of accident to the water power pumps. These pumps discharge into the new reservoir, which is at an elevation of 161 ft. above the pumps, supplies our high service, and has a capacity of 40,000,000 galls. Besides the 66 miles of service pipe in the city, there are 5.4 miles of pumping mains, and 2 miles of supply mains. The estimated value of our entire plant is about $1,500,000. CHAS. E. BOLLING, *Supt.*

GREENSBORO, N. C., March 9, 1888.

EDITOR ENGINEERING NEWS:—Our water-works will be completed May 1, 1888. They were designed by W. W. TAYLOR of this place. Water is taken from wells and springs by a Blake pump of 1,500,000 galls. daily capacity and pumped to a stand pipe which will contain 100,000 galls. The works are owned and are being built by the Greensboro Water Co. The pipes and specials are furnished by R. D. WOOD & Co. of Philadelphia. Eddy valves and Matthew Hydrants will be used. There will be about 75 hydrants, for which the franchise grants a rental from the city of $28.75 each. All above 75 at $35 each. FRED B. HUBBELL, Baltimore, Md., is our secretary and treasurer. The population of Greensboro is 5,000. THOS. B. KEOGH, *Pres. Greensboro Water Co.*

EUSTIS, Fla., March 7, 1888.

EDITOR ENGINEERING NEWS:—Water-works are needed badly at this place, and could be put in at a cost of $30,000, as there are a number of clear water lakes within the corporate limits. Our population is about 1,500. We once contracted for a system of water-works, but the contractor failed us.

GEO. W. CLEWCLE, *Town Clerk.*

COVINGTON, Ky., March 7, 1888.

EDITOR ENGINEERING NEWS:—New water-works are contracted for, and it is expected that they will be completed during the coming season. The new supply will be from the Ohio river 8 miles above Cincinnati. It will be pumped into an 80,000,000 galls. reservoir, of three compartments, which will have an elevation of 274 ft. When this reservoir is completed an entire change will be made in our present system, especially in the distributing pipes. The new work will cost $1,000,000. W. H. GLOBE, *Chief Executive Officer, Covington City Water Works.*

PADUCAH, Ky., March 5, 1888.

EDITOR ENGINEERING NEWS:—The Paducah Water Supply Co. of Baltimore, Md., on March 1, 1888, sold its entire works and franchise to the Paducah Water Co. of Paducah, Ky., a corporation organized under an act of the State legislature approved Feb., 20, 1888.

MUSCOE BENNETT, *Supt. Paducah Water Supply Co.*

KNOXVILLE, Tenn., March 5, 1888.

EDITOR ENGINEERING NEWS:—I have had to reconstruct the water-works reservoirs since coming here in 1884. The original construction was poor and expensive, and the reservoirs had burst 8 times, and emptied their contents into limestone cavities below. The works are now in good order and within a few weeks the company and the city have effected a settlement of a law suit regarding hydrant rental. There will be about 2½ miles of 6 and 8 in. pipe laid this season, and 35 hydrants added.

A. H. MARTINE, *Supt. Knoxville Water Co.*

TULLAHOMA, Tenn.,

EDITOR ENGINEERING NEWS:—The city is now being canvassed to raise stock to erect water-works. If a stock company is not organized, then the city council will be asked to issue bonds to build the works. Water will be pumped to reservoir from two large free stone springs, 70 ft. below the street level. Population is 3,000.

GEO. W. DAVIDSON.

NEOSHO, Mo.

EDITOR ENGINEERING NEWS:—The city is anxious to negotiate for water-works, or grant a liberal franchise to the right parties. We have plenty of good spring water within a quarter of a mile of the public square, and a stand pipe could be erected on an adjoining hill. Population is 3,500. Address, JAS. E. ALEXANDER or A. M. BALLOU, Neosho, Mo. LEE D. BELL.

HALSTEAD, KAN.

EDITOR ENGINEERING NEWS:—Bonds were voted some time ago for a system of water-works to cost about $23,000. An effort was made to sell these last fall, but the market was too dull. We shall try it again in the spring. Water will be pumped from a large well near the Little Arkansas river. Address, S. H. TUGO, Mayor.

B. N. BERRY, *City Clerk.*

BAXTER SPRINGS, Kan.

EDITOR ENGINEERING NEWS:—Water-works are now being talked of. The river is a quarter of a mile distant, and it is proposed to pump water from it to a stand pipes. Probable cost of works, $25,000. Nothing definite has yet been done. Population is 2,000.

H. R. CORBELL, *Water Commissioner.*

WAXAHACHIE, Tex.

EDITOR ENGINEERING NEWS:—We are agitating the water-works question, and will probably do something in the coming summer. When our city acts it will probably put in a $30,000 or $40,000 plant, the cost to be covered by an issue of bonds.

E. A. DU BOSE, *Mayor.*

TEMPLE, TEX., March 8, 1888.

EDITOR ENGINEERING NEWS:—This city is anxious to obtain a more efficient water supply, and to have its present system of mains extended. The company owning the works is not able to undertake the extension, and any company who would come here for the purpose, would be treated liberally in the way of donations.

GEO. E. WILCOX, *President Temple Water-Works Co.*

Water-Works Reports

Madison, Wis.—The Board of Water Commissioners have issued their report for the year ending Sept. 30, 1887, being their 5th annual report. The works are in good condition and the financial condition of the Water Department is satisfactory; the receipts for the year paid the operating expenses and the year's interest on the outstanding bonds and left a surplus of $939.96 in the treasury. The present wells limiting the supply, it was proposed to obtain an additional supply from a system of gang wells, similar to that at Brooklyn, N. Y.; experiments showed that the geological formation was not favorable, but that by boring 200 ft. down to rock, and tubing to that depth, a 6-in. well gave the same quality of water as the other wells and a daily supply of 115,000 galls. This is the seventh well and a contract has been let for 2 more. The waste of water is so great as to seriously diminish the fire pressure at times; the water is wasted recklessly. The consumption for November, 1886, was 20,000 000 galls., and in December, with cold weather, it was 25,000,000 galls.; an inspection resulted in reducing this to 23,000,000 galls. in January, and 17,000,000 galls. in February, with no freezing of pipes. When the inspection ceased the waste increased till the consumption was 26,000,000 galls. in August, reduced by another inspection to 21,000,000 galls. in September. Meters are recommended to prevent such excessive waste, which means an expenditure of $5,000 to $8,000 if the system is adopted generally. For fire protection a connection with the lake is urgently recommended. During the year 3¾ miles of 4 and 6-in. mains, 10 hydrants, 27 valves and 124 services (3,266 ft.) were laid. The population is about 12,063. The supply is by direct pressure from 7 artesian wells. There are 2 non-condensing Reynolds-Corliss pumping engines, with Knowles pumps combined; daily capacity, 1,500,000 and 2,500,000 galls. The total amount pumped was 261,308,160 galls., with an average head of 224 ft. There are 980 water takers. There is an analysis of the work; a diagram of the daily pumpage and a table of engine performance, etc., also a plan of the pumping station and location of the wells. JAMES CONKLIN is President of the Board. Superintendent of Water-Works, JOHN B. HEIM.

Nashville, Tenn.—The Superintendent of Water-Works, GEO. REYER, has issued his report for the year ending Sept. 30, 1887. The great demand for water last summer, an extremely dry season, taxed the pumps to their full capacity, and there was some complaint of scarcity of water. The average daily consumption was 8,522,762, an increase of 750,393 galls., over the previous year; in August and September it was over 9,000,000 galls. and no stand-pipe pressure could be maintained; only by filling the reservoir at night could the city be supplied. There are 4 compound, non-condensing Worthington pumping engines, daily capacity 2,500,000 galls. each, and 1 horizontal engine with vertical pumps, daily capacity 4,000,000 galls. The water is taken from the Cumberland river and pumped to stand-pipe and reservoir. There are 42 miles 2,850 ft. of 3 to 36-in. cast-iron pipe, and 4,321 services of lead and cast-iron pipe, ½ in. to 4-in.; 8 services are metered. The consumption for the year was 3,113,466,880. The population is estimated at 75,000. The waste of water is extravagant and reckless; inspection is not thought to give permanent results, and the city's experience with meters has not been satisfactory, and will not be until there is clear water. The meters wear very rapidly. There is a table of engine performance. With this report are the reports of the City Recorder, Board of Public Works & Affairs, Fire Department, Police Department, the Superintendent of Light, the Health Officer and the City Engineer. The latter includes tables of all work done on streets and sidewalks, sewers, etc